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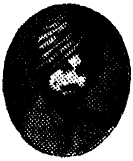

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Young Americans take pride in strong bodies, alert minds, and well-rounded personalities.

YOUR HEALTH and SAFETY

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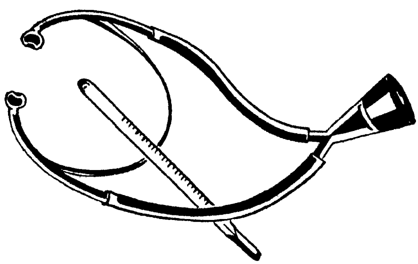

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BOOKS ARE WEAPONS IN THE WAR OF IDEAS

A WARTIME BOOK

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Preface

IT IS probable that never in history has any nation been more concerned about its health than this nation is today. Public conscience has been scandalized at the rejections for military service because of physical unfitness. Low-cost health clinics, hospital insurance, and medical insurance have made enjoyment of good health a new possibility to many millions of our people. The announcement of each dramatic new discovery in medical research is followed with pathetic eagerness. The rapid advance of this medical research and the availability of its discoveries have caught the public's fancy. Privately more and more of us are deciding that bad health is not inevitable. Publicly we have about concluded that the health of all of us is the concern of all of us.

Recently our high schools have joined in this growing movement for maintenance of good health. More and more schoolmen regard the health of our youth as the concern of the schools in which they study. Programs of physical education, fine as they are, have been found inadequate. Health cannot be maintained by exercise alone. Good health is something more than strong muscles and athletic ability. Required gymnasium periods will not guarantee physical fitness.

To speak of health or of public health is to speak of something abstract and intangible. Except for epidemic conditions, good health and its maintenance are individual, personal matters. The average person gives his body no thought until something goes wrong with it. Then from fear of doctors, or treatment, or operations, from ignorance of what is going on inside him, or from fear of the costs involved, the average person waits longer than he should before getting medical assistance.

The cure for this condition is information. It is the duty and the privilege of the school to supply this information. Not just a description of glands, muscles, bones, tissues. Not just the rules of hygiene. The information required for an up-to-date health course is more comprehensive. The entire concept of health has greatly expanded in recent years. It now covers, for example, the interaction of mind and body, and deals therefore with mental health. The few simple rules of hygiene which we remember from our own youth are not enough.

The association of health and safety in the same course is not new. Recent investigations disclose a growing tendency in high schools toward treatment of these subjects together. However, *Your Health and Safety* provides in one text for the first time enough material on safety for a thorough study of this subject.

There are two strong reasons for treating these subjects together. First, most school administrators feel that the 100,000 accidental deaths each year clamor for safety education in the schools — in high school as well as earlier. They have been trying unsuccessfully to find room for this education in an already overcrowded curriculum. Combining health with safety has proved a most satisfactory arrangement. Second, health and safety are naturally related. The combining of these subjects is more than convenience. They are both problems of personal, individual living. They are treated as related personal problems in *Your Health and Safety*.

The material on safety is not reduced to rules and axioms. No dynamic person wants to be namby-pamby safe. Safety education is not merely a protective fence for weaklings. To live safely is not to live the nonactive life of a vegetable. The approach in this book presents safe living as the basis of efficient, capable living. The informed person will make his home, office, school, highways safe not because he is afraid but because he knows everyone will live longer, more successfully, more happily.

In this book safety education is determined by the latest available figures on accidents. Those figures show that one-third of the accidents occur at home, that one-third involve automobiles, and that the remainder are due to athletic, industrial, and other causes. Accordingly, there are chapters on each of these major sources of accidents, with special attention to swimming and athletics. Of special importance is the chapter on safety problems in wartime. The latest recommendations on air-raid precautions and fire control are included.

The authors believe that a basic minimum of physiology is indispensable to the high-school health course. Without it, the rules of hygiene and public health seem no more than inconvenience.

This book is primarily a functional book as the titles of units and problems reveal. The emphasis is upon *application* of health knowledge to improve daily living. But the necessary physiology is included — necessary because it provides the *reasons* for health rules. This is pre-eminently a science book. Physiology is the science; health is the practical application of that science.

Your students will not be embarrassed by preaching in this book. Pious exhortation to lead a sober, physically upright life has no place here. The approach is objective. What are the scientific facts in the case? What are the known facts about narcotics, nicotine, and alcohol? The conclusions in terms of individual habits are left largely for each student to decide for himself.

The high-school health course starts with an enormous advantage over any other school course. Everyone is curious about his body and how it works. The initial problem of the health course is not motivation of interest in the subject matter, but capitalizing a natural interest already present. Every person at some time has thought of questions which he would like to ask the doctor. Most of us are either too timid or reluctant to take a doctor's time to get these questions answered. High-school students have questions such as these. For six years one of the authors has been coaxing these questions out of high-school students. In large part they form the foundation of the book. Many of them will be found in the study outlines at the beginning of chapters. The answers are given in the text. It is difficult to believe the increase in student interest aroused by these exploratory questions. The doubting teacher may make a trial of the method, however, before using the text.

The goal of this book is, of course, better living for the students who read it. Unfortunately, no one ever improves his health just by reading about it. The formation of good health habits requires an act of will. The authors hope that in providing the *physiological reasons* underlying good health habits they have provided the motivation for this act of will. In addition, at the end of each chapter there is a check list of health habits. These check lists are only a means — not a guarantee — that the student will put into effect in his daily living the information he has acquired.

It is hoped that this book will help break down any abnormal fear of illness by providing the student an understanding of his body and scientific evidence of how it works. It is hoped that it will also condition him against uncritical acceptance of patent medicines, nostrums, and health fads. Material bearing on these items appears in no single chapter but at every relevant point. The emphasis is on prevention of illness through hygienic living. The reader is directed to a doctor for diagnosis and treatment, if trouble arises.

The questions preceding each problem are in effect a study plan. Activities and exercises have been included as a means of applying and using the information in the text. The reading lists have been carefully prepared with an eye to materials of low cost and reasonable availability. Technical terms are pronounced and defined the first time they appear in the text. They are caught up again for easy reference in the Glossary at the close of the book. The drawings were prepared as teaching helps, limited in detail to the subject under discussion.

Valuable advice and criticism concerning parts of the manuscript have been given by H. B. McWilliams, biochemist, of the Thurston Research Laboratories; Helen P. Spears, physiology teacher in the Washington High School of Los Angeles, who also helped with preliminary sketches for some of the illustrations; Teresa Curtis Fulford, librarian of Hamilton High School, who made many suggestions concerning the references; Freda B. Daniels, who assisted with the preliminary planning of a portion of the book; and Ramona and Harold Diehl, who gave much friendly criticism and assistance in preparing the health section. The authors also wish to thank Dr. Leslie W. Irwin, Department of Education, University of Iowa, Iowa City, Iowa, and Dr. Bethana Deighton, of Chicago. The authors wish to express deep appreciation to them, and also to the many fine high-school students who have aided enthusiastically by asking questions, posing for photographs, and criticizing the manuscript.

All drawings and photographs not otherwise credited were made especially for this book: the drawings by Marion A. Cox and the photographs by Roy L. Stone.

THE AUTHORS

Unit I. *Getting Acquainted with Yourself*

LIFE! Mystery of all mysteries — and probably destined to remain so despite all probings of scientists. Yet we all experience exhilarating moments when we feel we are truly alive — one hundred per cent *alive!* It is with the hope of making such an awareness of radiant and abundant life more common and lasting that this book is written.

Strange that man should always have looked out upon the distant stars and sun with wonder and worship and should have waited until only the last few centuries to inquire into his own nature. The scientific study of mankind (*yourself*) still leaves much to be discovered. Nevertheless, enough knowledge has been gathered to help you to understand the functions of your body and to show you how to make better use of your talents and energies. Problem 1 is important, for it is intended to establish briefly the setting for the study of human life and to give some specific hints as to how you may go to work on that most fascinating of all subjects — yourself.

If you are a beginner, the human body is apt to appear to you as complicated as a telephone system seems to a novice. As you study the body, however, you will find that the fundamental facts concerning it are not difficult to understand. Problem 2 will give you a preliminary acquaintance with certain ideas and terms needed in the study of life, and an understanding of the parts of the body and how they work as co-operating units of a finely adjusted machine.

Problem 1. *What Is Your Place in the Scheme of Things?*

> The more I study nature, the more I stand amazed at the work of the Creator. I pray while I am engaged in my work in the laboratory. — PASTEUR

STUDY OUTLINE[1]

A. How earth and life came into existence
  1. How do scientists think the earth was created?
  2. Were living things all created at the same time?
  3. Does science contradict the possibility of a Divine Intelligence or God back of creation?
  4. In what ways are things still evolving?

B. The impulse for self-expression
  1. Do modern young people want to be superior? Do you?
  2. When is it right to seek self-expression?
  3. How can you help others by helping yourself?

C. How you can help yourself
  1. Is illness necessary?
  2. Can hygienic living really give more vitality and happiness?
  3. Is it worth while to try to develop your own personality?
  4. How can you determine a goal for self-help? Have you determined one?
  5. Having set a goal, how can you go about attaining it? Have you started working toward a definite goal?

WE ALL want to win health, friendships, and success in some serviceable activity; but many lose those precious possessions because they do not know the rules which govern their actions. Perhaps no one has better emphasized the need of knowledge of the principles of life and of nature in general than the great biologist Huxley, who wrote:

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[1] The purpose of each study outline is to stimulate serious thought on the part of the student rather than to demand specific answers.

> Suppose it were perfectly certain that the life and fortune of every one of us would, one day or another, depend on his winning or losing a game of chess. Don't you think that we should all consider it to be a primary duty to learn at least the names and moves of the pieces? . . . Yet it is a very plain and elementary truth that the life, the fortune, and the happiness of every one of us, and, more or less, of all who are connected with us, do depend on our knowing something of the rules of a game infinitely more difficult and complicated than chess. . . . The chessboard is the world, the pieces are the phenomena of the universe, the rules of the game are what we call the laws of Nature. . . . To the man who plays well, the fullest stakes are paid with an overflowing generosity. And one who plays ill is checkmated.[1]

It is the purpose of this book to explain some of the most vital rules of the game of life for the sake of those players who are out to win.

HOW THE EARTH AND LIFE CAME INTO EXISTENCE

Exactly how and when the earth and life came into existence is not known, but the painstaking work of many men in the various fields of science has given us interesting clues from which to construct the following fascinating story.

Several billions of years ago our sun was a vast mass of flaming gas which made its solitary way through space. Just how and when it came to be there is one of the many mysteries of our universe. But there it was, much as it is now, only larger. It constantly shot out huge quantities of material, but the pull of its own gravity always caused these smaller masses to fall back into the sun again. Then an incident occurred that marked the origin of our earth.

It is believed that a huge star traveling in a direction opposite to that of the sun came so close that its gravity pulled some of the sun's erupted masses farther out into space. The star went on its way, we know not where, but the huge masses of material it had pulled from our sun continued to revolve about the sun and finally became the planets (see Fig. 1).

One of these shapeless masses was to become the earth. It was about one tenth its present mass. It constantly increased in size

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[1] Thomas H. Huxley, "Liberal Education," in *Science and Education*, D. Appleton & Co., New York, 1901, p. 81.

1 Spiral nebula in the constellation of the Hunting Dogs. Enormous numbers of stars like our sun revolve in this universe somewhat resembling our own in general order and size. Do some of its suns have planets supporting life? Probably no one will ever know, but knowledge of such nebulae helps us to understand better our own universe and to realize that everything is in a state of gradual change. (Courtesy Mount Wilson Observatory)

by attracting smaller bodies to it. As it grew, its gravity increased correspondingly and the interior became hot from the pressure above it. This internal heat eventually caused volcanoes to form.

The earth quickly acquired a thin atmosphere; gradually water vapor collected around it and finally formed into rain when the earth had cooled enough to permit it to condense into water. Some of the water evaporated again and some of it sank into the ground; but most of it found its way into hollows and remained there in pools. Ultimately, parts of the earth's surface became predominantly land and other parts became mostly covered with water. Thus continents and oceans became sharply defined.

Finally the earth reached a stage when the atmosphere, the temperature, and the abundance of water on its surface offered an ideal condition for *living things.* (Can you tell what these conditions for life are?) In just what form they first appeared, where they originated, and whence they came are still unsolved questions. Scientific studies show, however, that at a certain stage in the earth's history the proper materials for life were brought together and there came into being something distinctly different from bare rocks and water. This "something" was the first faint beginning of life. This living substance has continued its activity through an endless succession of living creatures for approximately a billion years.

We know that the first forms of life must have been *plants*, because they had to be able to manufacture their own food from the lifeless rocks, sand, water, and atmosphere about them. This ability is possessed by all plants except parasites and not by any animals. It is believed that some of these early types of one-celled plants became so modified by changing conditions that they were unable to manufacture their food. Of these changed cells, some developed the power to move and to respond to things about them. These alone, among the changed cells, were able to continue their existence, because they were the only ones able to seek out and engulf other cells containing food. These new cells became the ancestors of all forms of *animal* life.

Once life started, it began to change in many ways to adapt itself to varying environmental conditions. It is believed that the origin of all the forms of plants and animals that have ever existed, culminating in man, can be traced to these simple beginnings. This theory is the best explanation yet devised for the facts that are known. It does not, however, explain the controlling force that brought it all to pass.

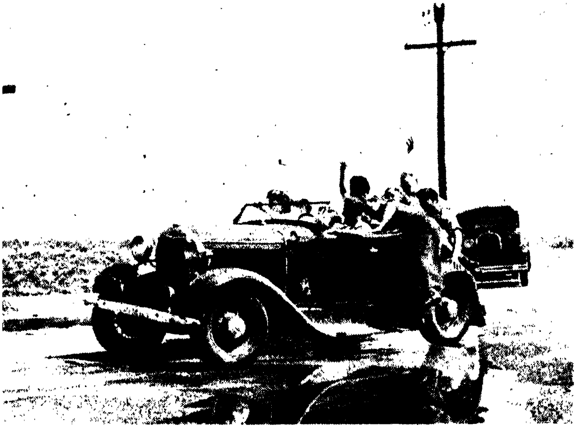
THE IMPULSE FOR SELF-EXPRESSION

The story of mankind which has just been told is perhaps not more than the first act of a drama that scientists expect to go on and on through billions of years to come. Let us pause for a moment, take a close-up of modern youth, yourself in particular, and try to get an idea of your role in the whole scheme of things.

Man's urge for growth and progress. All human beings are different from other forms of life in certain vitally important respects. One of these distinguishing characteristics is an unquenchable desire for a better life. You will rarely find an adult who is entirely satisfied with his life as it is. On the other hand, most people want better jobs or more money or more friends or better health or more education or greater peace of mind or something else that they believe will enable them to live more completely. Even whole nations of people are willing to risk their lives in the hope that thereby their children may live better.

Misinterpretations of personal desires. Those who either ignorantly or willfully refuse to grow in accordance with natural law are of three types. First, there are the drifters who have given up. They let the stream of life carry them where it will and buffet them about. Oftentimes it carries them into a little side eddy where they go around in circles while the main stream rushes on, passing them up completely.

Second, there are the plungers, who blindly rush into the flood without goal or preparation. They thrash about aimlessly, exhaust their strength, and wonder why they get nowhere. Some wake up and try again, but the majority fall back into the first class and become drifters; for by this time it is often too late to turn back and get the necessary education and perhaps restore the health they have destroyed.



2 High-school pupils sometimes express their inner urges in undesirable or even dangerous ways. Here they are not only risking their lives, but they are violating the law by hanging on the outside of the car, by obstructing the driver's vision, and by distracting his attention.

Third, there are the misfits, who attempt to go contrary to the current. They express their desires in a destructive way which brings suffering to others and sooner or later to themselves. People who foolishly think they can play the game of life according to their own rules include some who wreck their health by wrong living, some who become antisocial criminals, some who attempt to undermine civilization, and some who greedily amass wealth at the expense of others. They may seem to "get away with it" for a time, but they pay in the end. Anyone out of step with the law of progress simply does not survive. The tide of life sweeps on.

Positive interpretations of individual desires. Living in accord with the law of growth brings great and lasting success, happiness, and peace. A famous teacher and philosopher, William H. Kilpatrick, once said, "The joy of living comes at the growing edge." A child may be content for a time to use a hammer for aimless pounding, but soon he wants to pound nails in a board. Then he wants to make something; and when he has learned to make one thing, his interest lapses until he starts mastering something new.

A person carries the need for self-improvement through life. In adulthood he may have to be satisfied with doing routine work for service to society and for a livelihood for his family; but unless he makes his out-of-work hours furnish him a chance to grow in ideas, social contacts, or victories over self, life soon becomes drab and utterly without zest.

Is personal progress selfish? World events of recent years have emphasized more than ever before the need for strong, clear-thinking individuals. It needs young men and women who are convinced that "You can help others most by being physically and mentally healthy and happy yourself." If you doubt this, think it over. How does this apply to you in relation to your home, your school, and your country?

If you live for self alone, you will soon find yourself friendless, and off in a little side eddy of your own. On the other hand, if you give yourself too much to others you may be in danger of spreading yourself thin and neglecting your personal growth.

How to recognize the urge for growth. Don't look for a sudden, overwhelming impulse to become a great statesman or prophet or inventor. Life does not work that way. Growth comes slowly and undramatically. In youth growth comes through gaining friends, excelling in sports, helping win for the school, succeeding in various school subjects, turning out the finest possible work in typing, shop, music, or art, making your home better or happier, carrying on a hobby, and always doing your best (Fig. 3). As you grow older, these activities will change into the desire for a job, for achievement, for a home of your own, for a widening circle of friends, and for specific service to mankind.

3 High-school pupils can learn many worth-while ways of expressing their urge for activity and growth.

HOW YOU CAN HELP YOURSELF

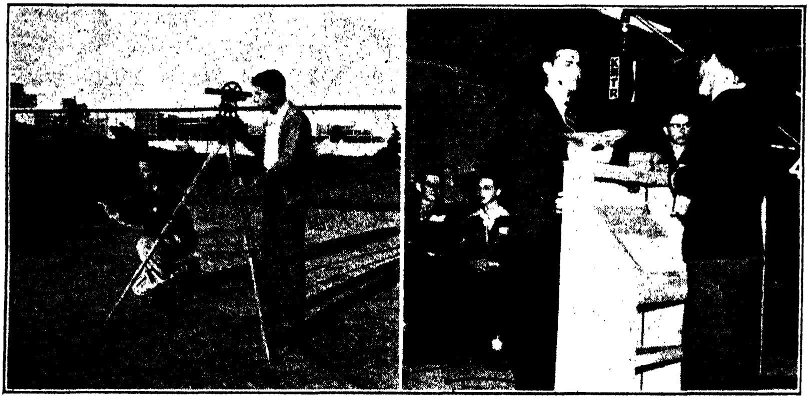
The ordinary life experience will normally force you to learn eventually by hard knocks. You may, however, take the easier way by consciously directing your progress, and little by little seeking to develop finer ways of expressing yourself in work, play, and social contacts. A full, rich life requires a strong, healthy, and well-trained body and mind. It's up to you to develop them.

Take a look at yourself. The game of self-development is the most exciting and gratifying of contests. It can last throughout life, keeping you young and interested in living. Best of all, it is a game in which nobody needs to lose, and everybody can win every day! By answering *frankly* the following questions you can take a good square look at yourself:

1. Is my body as healthy and strong as I should like? Is it responsive in games, work, and other activities that require muscular skill?
2. Am I handicapped socially because I don't know how to join in such social sports as dancing, badminton, swimming, and similar activities?
3. Am I as alive mentally as I really want to be? Do I reason, learn, remember, and concentrate well?
4. Does my personality fit my ideals for myself? Does it win the confidence of others? Does it attract the kind of friends I want? Do I feel at ease with my fellow human beings? Do I get along well with others? Do others respect and admire me? Do I respect myself and enjoy my own company? Is there anything about myself I don't like? If so, exactly what is it?

If you are honest with yourself, and still find nothing to be desired in the way of personal improvement, you are so unusual as to be almost unbelievable. On the other hand, do not try to make yourself over all at once; for if the task is too great for your present ability, you are likely to experience the disappointment of failure instead of the supreme thrill of self-mastery. Therefore, start first with just *one thing* you want to accomplish. You do not have to know how to do it at the start, but you do have to *want to do it.*

Fundamental cause of illness and health. The next paragraph contains a significant truth concerning the healing of disease and



4 Success is a habit, achieved by consistent effort. The difference between the expert and the average depends upon the degree of mastery of detail.

the strengthening of the body. This idea is fast revolutionizing medical practice. Reread this section often during the course. Each time you do, it will have deeper significance for you.

The body is composed of infinitely tiny units called cells (page 25) which receive nourishment from the blood. All life activities of the body are carried on by these tiny cells (trillions of them!) working together. All healthy cells will work efficiently if unhindered and given the proper conditions and working materials. It has been shown experimentally that these proper conditions are (1) sufficient oxygen, (2) the right food and vitamins, (3) proper elimination of wastes, and (4) freedom from undue irritation, disease germs, toxins, and other harmful factors. Aside from accidental deformities, all human physical ailments are due to the fact that *some* of the body cells lack the necessary things mentioned above. Therefore the cure for any ailment lies in determining what is wrong with the environment of the cells, and remedying the condition. All methods of healing (medicines, operations, rest, massage, diet, heat, or other forms of healing) simply help furnish the cells with the right conditions — but the cells do the healing.

Charting your course for self-improvement. Throughout your entire study of this book you should be continually rechecking yourself and often start new projects according to the following four steps:

Step I. Setting the goal. Decide definitely on one specific goal or project in self-improvement and formulate a definite statement of it. A few goals formulated by other young people are listed here as suggestions of the type you might wish to select. You will think of many similar ones.

A. Physical-health goals. To:
   1. Improve my complexion.
   2. Take better care of my hair.
   3. Gain or lose weight.
   4. Prevent colds.
   5. Overcome constipation.
   6. Increase my "wind" and endurance.
   7. Improve my posture.
   8. Learn to play tennis (or some other game).
   9. Take proper care of my eyesight.
   10. Overcome nervousness.
   11. Get plenty of sleep.
   12. Develop the habit of breathing deeply.
   13. Develop the habit of daily exercise outdoors.
   14. Develop the habit of getting up early.
   15. Develop the habit of chewing food well.
   16. Develop the habit of taking a shower every morning.
   17. Break the habit of smoking.

B. Mind and character goals. To:
   1. Learn to study better.
   2. Develop the habit of concentration.
   3. Develop the habit of getting to work promptly.
   4. Develop the habit of doing things on time.
   5. Develop the habit of reading for self-development at least fifteen minutes a day.

C. Personality-development goals. To:
   1. Win more friends.
   2. Learn to control my temper.
   3. Learn to get along well with my brothers and sisters.
   4. Learn to get along better with my parents.
   5. Break some specific habit that is detracting from my personality.
   6. Develop the habit of being polite.
   7. Develop the habit of being pleasant.
   8. Develop calmness and poise.
   9. Develop a more cheerful attitude toward life.
   10. Develop the habit of doing what I am told to do quickly and pleasantly.
   11. Develop the habit of being dependable.
   12. Develop the habit of a morning quiet period.

Let your project be something you sincerely desire to do *for yourself.* If it takes you longer than a semester to attain it, don't worry; the main thing is to select a goal and work toward it until you win. When you have mastered one thing, start another.

Step II. Studying the situation. Having set a goal, try to find out everything you can about it. For instance, if you wish to stop biting your nails, read all you can about "habits" and "nervousness," instead of hunting merely for something about "biting finger nails." As you study the facts about your problem, list the ideas that may help you apply the general principles to your special difficulty.

If you have a physical difficulty, check yourself carefully on your daily health habits to locate if possible the source of the trouble. Problems 3–21 will be helpful. If you wish to improve mentally, read Problems 15, 16, 19, and 20 and some of the references for Units VI and VII. If you are working to develop your personality, study especially Unit VIII.

Do not limit yourself to this text and its references. Use your library, and, if necessary, ask help from your teachers and parents. If your difficulty does not yield to the simple, safe suggestions given in this book, you should *see your doctor.*

Take warning: Don't tell others about your new ambition until you have it fairly well accomplished. That saves your enthusiasm for work instead of wasting it on talk. Also, everybody will have some advice to give you, and often the most ignorant and superstitious will have the most to say. Test the authority for each statement you hear or read. Study the suggestions in *How Scientific Are You? A Guide to the Pupil's Thinking* in the Appendix. Use the ideas given there until they become mental habits which you practice unconsciously.

Step III. Making your score chart. As a result of your study you should have determined a few specific procedures which you think will bring about the desired result. For instance, if your goal is to clear your complexion, your reading and self-analysis may indicate that you are eating too much sugar and starch, that you are not exercising enough, and that you do not drink enough water.

Another person with the same problem might find that he is not getting sufficient sleep, is not eating enough bulky food, and is not thoroughly cleansing the pores of his skin. Another person's poor complexion might have still different causes. That is why each person must analyze his own case carefully. It also explains why the cure for one individual may not help another. If you have difficulty in determining what you should do, talk it over with your teacher. If the trouble is at all serious or complicated, consult a physician [1] before you attempt to do anything for yourself.

Whatever you decide to do, *be sure each thing is absolutely harmless.* Never experiment with anything doubtful. Some patent medicines may be particularly harmful and may start destructive lifelong habits that are almost impossible to overcome (see Problem 23). Even good things may be overdone. For instance, a reasonable amount of exercise is necessary for most people; but in the extreme it may overtax the heart, and in order to prevent or cure certain illnesses some people may not be allowed to exercise at all for a while. Therefore start everything gradually and don't become a faddist or extremist.

You should now formulate a chart for keeping your score daily. There are many ways of doing this. Devise one that fits your project and seems most handy and easily checked. A few forms are suggested here. One of the examples given at the beginning of this section — clearing the complexion — is suited to the following form (remember, these particular items are *examples* only):

Form A

Things to Do Daily	*Date and Record*				
	10/1	10/2	10/3	10/4	10/5
1. No sweets between meals	+	o	+	+	±
2. Half portions of starchy foods	A	A –	C	A	B
3. Half portions of desserts	1	4	1	3	5
4. Extra fresh fruit and vegetables	2	1	4	3	5
5. Sixty minutes outdoor exercise	60	70	30	0	45

This chart shows four methods of checking yourself. In item 1, + indicates that it was accomplished, o shows failure to do it, and ± indicates a *little* overstepping of the rules. In item 2, a school grading system is used: A means success, E means failure, and letters between show varying degrees of success. Items 3 and 4 employ the same system with the use of numbers 1 to 5 instead of letters A to E. In item 5, the time spent is recorded each day. Use any method which shows your progress and takes the least time to check. Use the same method for all items, if possible.

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[1] Throughout this book either of the terms "doctor" or "physician" refers to a reputable physician who is licensed to practice medicine and surgery.

Form B. For some projects you may record your progress on a calendar with large spaces.

Form C. For habit or personality projects you may like the diary form, as follows:

Date .... Habit decided upon ....

I began to practice my habit on .... by doing ....
On ...., I ....
On ...., I ....

In this form, you simply record your progress daily in brief sentences.

Form D. If you have no special way in which you wish to improve, you may want to score yourself daily on general health habits such as the following:

Health Score Card, Form D[1]

Today did I:	*Points*	*Date*	
		10/1	10/2
1. Sleep at least 9 hours (for high-school pupils)?	5	....	....
2. Relax completely at least 15 minutes during the day?	3	....	....
3. Have one hour outdoor exercise?	5	....	....
4. Take a bath?	3	....	....
5. Wash hands with soap and water before each meal?	5	....	....
6. Brush teeth at least twice?	2	....	....
7. Have at least one bowel movement without using a laxative?	5	....	....
8. Eat according to the "Master Diet Plan" on p. 66?	20	....	....
9. Drink at least 6 glasses of water?	4	....	....
10. Eat slowly, chewing food well?	5	....	....
11. Eat and sleep at regular hours?	5	....	....
12. Eat nothing between meals (except designated foods for underweights)?	3	....	....
13. Sit and stand erect at all times?	10	....	....
14. Live and sleep in well-ventilated rooms?	5	....	....
15. Control emotions even in small matters so as to be pleasant and calm?	10	....	....
16. Control thoughts at all times so as to keep hopeful, busy, and free from worry, fear, and self-pity?	10	....	....
Total	100	....	....

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[1] It is assumed that of course you do not use alcohol, tobacco, or any other habit-forming drug. If you do, subtract 25 from your score.

No matter what form of chart you use, make it small enough to keep handy where you cannot help seeing it. Keep it on your mirror, or in your most used pocket or purse, or make it the first page of your notebook, where it will remind you often of your goal.

Step IV. Working your plan. Set a definite *time* for doing the things you plan. Decide in exactly what hours you are going to get extra sleep or outdoor exercise or do your studying. Allow more time for meals so that you can eat slowly, give yourself only a certain amount of time for certain tasks so that you can't waste time, and so on. Also have a set time each day for filling in your check chart.

Your project may be such that whatever you try will be experimental. Try each thing long enough to be sure that your conclusions are justified. Then if you find one thing doesn't work, try another.

Launch your new adventure immediately and with as strong a start as possible. Do not permit any exceptions to your new plan until it has become firmly established in your life. It is a great temptation to say, "Just this once won't hurt," but every such step backward wastes time and energy and makes it that much harder to reach the goal. If you slip back thoughtlessly, do not become discouraged, but start afresh. The important thing is that you *finish* sometime.

Conclusion. Since evolutionary processes are still going on and we are a part of them, it is useless to try to stop human evolution. Each individual can only do his share in directing the urge for progress both within himself and in society so as to bring about the best ends possible in the least destructive way. Hence self-improvement is the most challenging and gratifying sport known. Its rules are definite, following the laws of nature, and everyone can win.

ACTIVITIES

1. Self-check on your study of this problem. To test your comprehension of this problem, turn to the study outline on page 2 and see if you can answer all the questions there. Make your answers complete, with explanations and illustrations. If you have trouble in answering some of them, read again corresponding parts of the problem.

You may write your answers in your notebook or use them as a basis for class discussion.

2. A personal project. Start work toward one *goal for personal improvement* according to instructions on pages 12–15.

3. A scrapbook. Start saving clippings on some health problem in which you are interested, or on current events in the progress of medicine, surgery, physiology, or hygiene.

4. A bulletin board. Start a display of current articles of interest in health and personal development. Appoint a committee to be responsible for removing old material and keeping new displays attractive.

5. Making posters. Get your art teacher to allow you to make some colorful posters portraying the everyday value of health and vitality. Exhibit the best ones in the halls of the school.

6. A school health committee. If your school has no health and safety committee, consult with your principal and student-body president concerning the formation of one. Such a committee can find many worthwhile projects to promote the health and safety of pupils and teachers.

7. Making a school calendar. As a group project, throughout the term make a 12-month health calendar for the following school year, to be distributed to pupils the next September. Make an illustration for each month to inspire pupils of your school to participate in some healthful activity appropriate to the month and locality. Below each picture, state definitely at least five specific health hints that are unusual and effective.

Types of themes that may be used for different months are: accident prevention for wet weather; fire prevention for dry weather; life saving for a swimming month; poster for final examination month; the prevention of colds for early winter; health habits for the holidays (December); and relaxation and real recreation for a vacation month. A suitable quotation, such as those at the beginning of each problem in this book, may be added, and also a bit of original rhyme.

If you prefer, use photographs, instead of drawings, of school leaders doing the activities suggested. The school artists or photography classes could make the pictures in most interesting poses for you. Your printing department can print the calendars (or in smaller schools mimeograph them). Have the calendars punched to fit your school notebooks. Advertise them at a health assembly and sell them to the student body at one to five cents apiece to pay the cost.

SUGGESTED REFERENCES

Clendening, Logan, *The Human Body,** Alfred A. Knopf, New York, 3d ed., 1941, Chap. II.

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* For advanced pupils and teachers.

Diehl, Harold S., *Healthful Living,** McGraw-Hill Book Co., Inc., New York, new ed. rev., 1941, Chap. I.

Emerson, W. R. P., "Health for the Having," *Reader's Digest,* **32** : 47–50, May, 1938.

Gulick, Luther H., *The Efficient Life,* Doubleday, Doran and Company, Garden City, New York, 1928 (O.P.), Chaps. I, II, III.

Hopkins, M. A., "You Can Make Over Your Personality," *Scholastic,* **32** : 10–12, Feb. 12, 1938.

Hull, T. G., "Looking at Health," *Hygeia,* **16** : 323–5, April, 1938.

Link, H. G., "Rediscovery of Man," *Reader's Digest,* January, 1939.

McDivitt, H., "Health Exhibit: contrasts of right and wrong health practices," *Hygeia,* December, 1938.

Morgan, J. E., "Your Health in the Making,"* *National Education Association Journal,* February, 1939.

Rogers, J. F., "Student Interests and Needs in Hygiene,"* *United States Office of Education Bulletin,* 1937.

Sadler, Wm. S., *Essentials of Healthful Living,* The Macmillan Company, New York, 1925, Chap. I.

Williams, H. S., *Why Die Before Your Time?* Robert M. McBride, New York, 1934.

* For advanced pupils and teachers.

Problem 2. *What Is the Nature of Your Body?*

Our life contains a thousand springs,
And dies if one be gone.
Strange! that a harp of a thousand strings
Should keep in tune so long. — WATTS

STUDY OUTLINE

A. Your energy and the material you are made of
  1. Of what *materials* are things (including yourself) made?
  2. Where does the *material* come from to make "new" things (*i.e.*, to make a plant or a child *grow*, or to make a new machine)?
  3. How can food go through the walls of the intestines and blood vessels to feed all parts of the body?
  4. What is energy? Where and how do you get it?

B. How your body is organized
  1. How do living things differ from nonliving things?
    a. In the way they are built (structure)?
    b. In the materials they are made of?
    c. In the things they do? (What do all living things do that nonliving things cannot do?)
  2. Why are different types of cells shaped differently? What do some of them look like?
  3. How can such tiny cells do the *big* tasks necessary for a human being? How are some types arranged for co-operation?

C. Division of labor among the systems of organs
  1. What are the names of the systems of organs of your body? What does each system do for you?
  2. What determines to which "system" an organ belongs?
  3. What organs are found in each system?

HOW much do you actually know about your body? Did you ever stop to think what you are made of? Do you know that the raw materials in your body could be bought for about 75 cents? What would you buy to make *you?*

This problem will give you a broad survey of your *body as a whole,* and how its parts work together. It will help you to understand better all the later problems, in which the parts of the body will be studied separately and in detail. At the beginning, however, there are three types of facts that you should know about yourself, namely: (1) the materials of which you are made; (2) how these are put together to make you a living being; and (3) how you are kept alive.

Important Note: *This is an introductory problem intended to give you merely a broad overview. It may raise many questions which cannot be answered until you take up the detailed study in later problems. Do not attempt to memorize the material in this problem but simply try to understand the facts and their relationships.*

YOUR ENERGY AND THE MATERIAL YOU ARE MADE OF

During every moment of your life (awake or asleep) millions of microscopic laboratories (your body cells) are changing air, water, and food into heat to keep you warm, into energy for work and thought, and into growth materials for your development. Let us see how these cells live and work.

Building materials. Chemists have discovered that everything in the universe, from stars to stones, is made of 92 different kinds of "pure" substances called *elements.* Some of the commonest elements are oxygen and hydrogen (which compose water), carbon (coal or charcoal), and the familiar metals such as lead, copper, silver, and gold.[1] Each element has a symbol which represents it, such as "O" for oxygen and "Fe" for iron.

Each element is made of particles called *atoms,* too tiny to be seen even with a high-powered microscope. A teaspoonful of any substance consists of millions of atoms. All the atoms in any

[1] All chemistry books and large dictionaries give a complete list of elements.

element are exactly alike. Since there are 92 elements, there are 92 kinds of atoms. Even though atoms are so extremely tiny, each one weighs a definite amount and is a certain size.

Everything made of atoms (which includes all material substance in the universe) is called *matter*. All matter, therefore, has weight and occupies space. All matter exists in a *solid*, *liquid*, or *gaseous* state. (By this definition, is air matter? If not, how can air in tires hold up a 10-ton truck?)

Compound substances. Most familiar objects are made of several kinds of elements. A substance thus formed of different kinds of atoms combined in definite proportions is called a *compound*. For example, water is a compound made up of two colorless gases, hydrogen (H) and oxygen (O), in the ratio of 2 to 1. Hence the chemical formula for water is H_2O. This really means that the particle, called a *molecule* (mŏl′ĕ-kūl), of water is made up of two atoms of H and one atom of O, chemically joined together. Study the diagrams above, which show molecules of some common compounds. Each letter represents one atom.

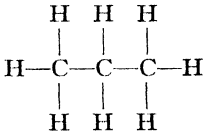
A. Water (H_2O)

H—O—H

B. Salt, or sodium chloride (NaCl)

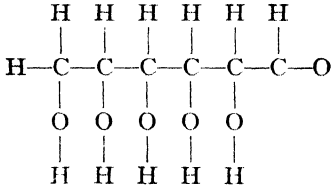
Na—Cl

C. Propane, a paraffin (C_3H_8)



$$\begin{array}{ccccccccc}
 & & H & & H & & H & & \\
 & & | & & | & & | & & \\
H & - & C & - & C & - & C & - & H \\
 & & | & & | & & | & & \\
 & & H & & H & & H & &
\end{array}$$

D. Glucose ($C_6H_{12}O_6$)



$$\begin{array}{ccccccccccccccc}
 & & H & & H & & H & & H & & H & & H & & \\
 & & | & & | & & | & & | & & | & & | & & \\
H & - & C & - & C & - & C & - & C & - & C & - & C & - & O \\
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 & & H & & H & & H & & H & & H & & & &
\end{array}$$

Your body is made of a vast number of such compounds. They are all formed, however, of different combinations and proportions of about 17 different elements (see page 25). All foods likewise are compounds. Food must furnish all the elements your body needs or you will suffer some deficiency. For instance, you cannot build bones or keep them healthy without calcium and phosphorus.

Changing the form of things. The law of conservation of matter holds that *matter cannot be created or destroyed — only transformed from one form to another.* When you gain weight, nothing new has been created; your cells have merely rearranged food atoms into "flesh and bone." Similarly, food is not destroyed, but simply changed in form. When wood is burned, it is transformed into carbon dioxide (a gas), water vapor, and particles of smoke and ashes. All of these together weigh exactly the same as the original wood.

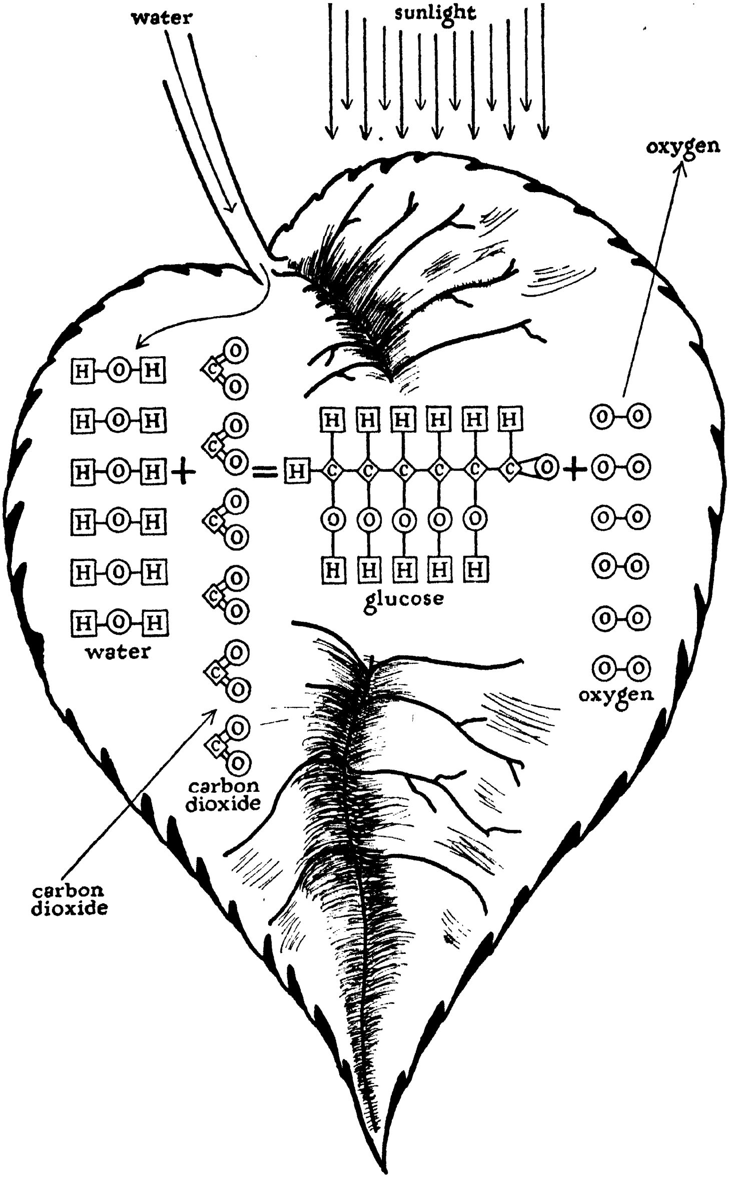
Getting things done — energy. Matter never does anything of its own accord; it must always be acted upon by some form of energy. *Energy is the power or capacity to act or to do work.* There are five forms of energy: (1) mechanical energy, *i.e.*, the force of a waterfall or the pull of muscles; (2) chemical energy, *i.e.*, energy stored in gasoline, dynamite, or food; (3) heat, *i.e.*, energy that runs steam engines or cooks food; (4) electricity, *i.e.*, energy that runs motors, illuminates electric bulbs, or possibly enables you to think; and (5) light, *i.e.*, energy that produces photographs and makes plants grow.

Thus our universe consists of material substance or *matter*, and invisible force or *energy*. Energy operates according to a law of conservation similar to that for matter, namely, *energy cannot be created or destroyed — only changed from one form to another.* For example, you cannot have vitality unless you eat energy-yielding foods and furnish the correct conditions for converting it into physical and mental power.

Your own energy. Your body cells liberate energy from food by a burning process. This may be very fast, as in an explosion, or so slow as not even to produce heat. All burning is called *oxidation* because in every case some substance is combined with oxygen, which is usually obtained from the air. If a flame is smothered, *i.e.*, deprived of oxygen, the fire goes out. You cannot live more than a few minutes without breathing because body cells must have a constant supply of oxygen to combine with food.

How energy is stored in food. In all foods the two elements which are burned (oxidized) are carbon (C) and hydrogen (H). When the carbon is oxidized (combined with oxygen), it forms carbon dioxide gas (CO_2), which you then breathe out. When the hydrogen part is oxidized, it forms water (H_2O), which you eliminate as perspiration and urine.

How did the carbon and hydrogen get into the food in the first



5 The green leaf is the original factory which manufactures all our food. Where does the leaf get the water? Where does the carbon dioxide come from? What becomes of the glucose (sugar) after it is manufactured? What becomes of the by-product, oxygen? (See page 23.) Of what importance are these facts to you? (From Ella Thea Smith's *Exploring Biology*, Harcourt, Brace and Company)

place? The answer is that some green plant put them there, and the sun's light (*not* heat) furnished the energy. This most remarkable process is called *photosynthesis* (fō′tô-sĭn′thê-sĭs), from *photo*, meaning light, and *synthesis*, meaning putting together.

The green leaf is really a kind of factory. The raw materials it uses are carbon dioxide gas (CO_2) from the air, and water (H_2O) from the soil. The CO_2 enters through tiny holes in the leaf and the H_2O by way of the roots. Instead of using water power or electricity to run its machinery, this factory uses light energy.

As soon as the light shines on the leaf the action starts: some of the C, H, and O from the CO_2 and H_2O are combined to make the simplest type of sugar molecule ($C_6H_{12}O_6$) (study Fig. 5). From this molecule are formed all *carbohydrates* (kär′bô-hī′drāts), or starches and sugars (see Problem 5, page 86).

A few plants rearrange these three elements, C, H, and O, into *fats* (olives, avocados, and cotton seeds). Most plants also combine nitrogen (N) with some of the C, H, and O atoms in such a way as to form *proteins* (prō′tê-ĭns, principally in peas and beans).

To each of these three fundamental classes of foodstuffs, plants add more or less of certain minerals from the soil. (See Table I, page 46, for substances contained in various foods.)

Some plants store the finished product in their roots (potatoes, beets), others in their stems (celery, rhubarb), or leaves (spinach, lettuce), or fruit (oranges, apples), or seeds (wheat, peas). All animals, including man, are dependent upon plants for their energy. They eat either the plant or the animal which in turn has eaten plants.

Movements of molecules. All molecules, both in our bodies and in more solid objects, are constantly engaged in tiny, unseen movements. If free, they may move some distance, as when perfume molecules from flowers scent the air about them. The movement of molecules from one place to another is called *diffusion*.

Sometimes molecules will pass through a porous membrane, as when digested food penetrates the intestinal wall which separates it from the blood stream. Plant roots in a similar manner admit water and dissolved minerals. Such diffusion of gases or liquids through a membrane is called *osmosis* (ŏs-mō′sĭs).

Some substances, like sugar, will dissolve in water and pass easily through animal membranes. Most foods, however, like egg white, fats, and starches, consist of large molecules that will not readily dissolve. They must be changed by digestion into a soluble form in order to be absorbed into the blood stream.

Acids versus alkalies. All substances which dissolve in water produce either an acid, alkaline, or neutral reaction. *Acids* taste sour and turn blue litmus [1] red. Familiar acids are vinegar, lemon juice, and boric acid.

Alkalies feel soapy and turn red litmus blue. Familiar examples are lye, ammonia, and milk of magnesia.

Acids and alkalies are chemical opposites because they counteract each other, forming a *neutral* substance which is not like either of them. For example, in cooking, baking soda is used to neutralize the acid of sour milk and the result is neither bitter like soda nor sour like milk.

HOW YOUR BODY IS ORGANIZED

Scientists now understand the structure and action of the body fairly well, but the careful study of it was impossible before the microscope was invented. About 250 years ago a Dutch lens grinder named van Leeuwenhoek (vän lā′vĕn-hŏŏk′) constructed a microscope through which he saw moving things he called "wee beasties." He was so fascinated by them that he devoted his life to the study of these tiny forms of life which he found in almost everything he examined — rain water, the scum from his teeth, or the transparent tail of a tadpole. His accounts of minute forms of animal life, of bacteria, and of circulation of the blood reveal his amazement, enthusiasm, and diligence; and they are full of human interest.

Living cells. While van Leeuwenhoek worked in Holland, an English scientist, Robert Hooke, was also at work with a microscope. His examination of a very thin slice of cork reminded him of honeycomb and he called the little sections "cells." Thereafter *cell* became the name for the smallest structural unit of plants.

That both plants and animals are made of cells was not known until 1839, when two German scientists announced what has become known as the *cell theory*. Schleiden, a botanist, and Schwann, a zoologist, worked together and finally came to the conclusion that *all living things are composed of cells.*

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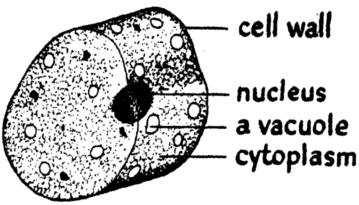
[1] Litmus is a dye that is made red by acid solutions and blue by alkaline solutions. Always use litmus to test a solution because tasting or feeling it may be dangerous unless it is sufficiently diluted with water. *Never* taste an unknown substance.



6 A typical cell. The suspended bodies within the meshwork of protoplasm are nonliving substances such as food granules, pigment bodies, drops of oil, and waste materials.

What is a cell? As you study the parts of various plants and animals under a microscope you will observe a wide variety of shapes and sizes of cell structure. Figure 8 shows a few of the types within your own body.

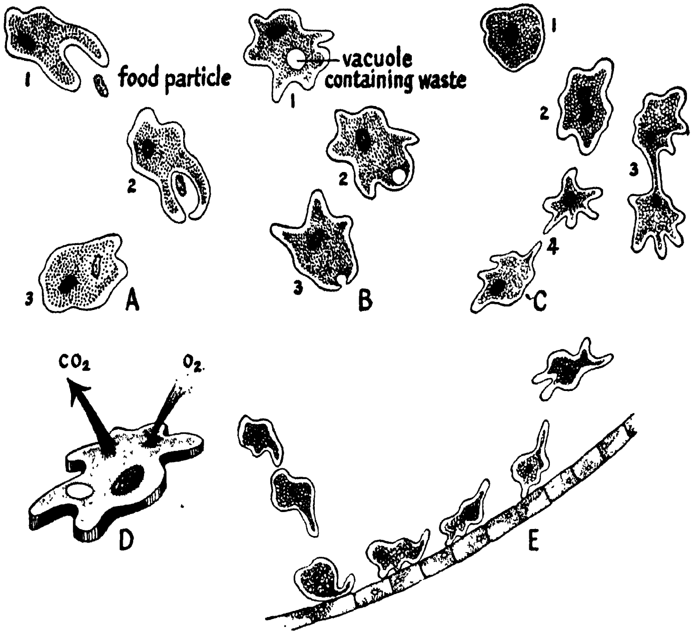
Regardless of shape or size, all cells are composed of tiny bits of a jellylike *living* substance called *protoplasm* (prō′tô-plăz’m), enclosed in a thin cell wall (Fig. 6). Within each is a speck of denser protoplasm called the *nucleus* (nū′klê-ŭs). The nucleus controls the life processes of the cell such as taking in food and excreting wastes. The cell walls keep the protoplasm of different cells from running together in a formless mass. The cell takes in and gives off materials only by osmosis through its wall. The portion of protoplasm around the nucleus is called the *cytoplasm* (sī′tô-plăz’m).

Protoplasm — the life substance. Protoplasm is a dense, practically colorless and transparent liquid. Under high magnification, it generally has the structures shown in Fig. 6. In the living state it is constantly in motion, but after death it changes to a solid and the body becomes rigid.

Protoplasm in the various parts of the human body contains the following chemical elements:

oxygen (O, 65 per cent)
carbon (C, 18 per cent)
hydrogen (H, 10 per cent)
nitrogen (N, 3 per cent)
calcium (Ca)
phosphorus (P)
potassium (K)
sulfur (S)
sodium (Na)
chlorine (Cl)
magnesium (Mg)
iron (Fe)
iodine (I)
silicon (Si)
manganese (Mn)
fluorine (F)
copper (Cu)

and perhaps traces of other elements. For the most part, these elements are combined in your body in various complex compounds.



7 How an ameba carries on life processes. *A*. Moving toward food and taking it in. (Follow its action in *A*–1, 2, and 3.) *B*. Eliminating waste. *C*. Growing and reproducing. *D*. Absorbing oxygen from air in the water and throwing off carbon dioxide (breathing). *E*. Showing sensitivity — ameba meets an obstacle, extends several arms, and moves where no obstacle is felt.

Although the first four elements named on page 25 make up 96 per cent of your weight, you must not suppose that these are more important than the others. For example, the absence of the tiny speck of iodine in your body (0.00004 per cent of your weight) would have resulted in serious impairment of your health. It takes every one of these elements to make your body complete and healthy.

What living cells can do. If you will compare a living with a nonliving object, you will find that the former is characterized by its power to (1) *move*, (2) *take in and assimilate food*, (3) *eliminate waste*, (4) *breathe*, (5) *grow*, (6) be *sensitive* to its surroundings, and (7) *reproduce* new individuals of its own kind.

These activities are the characteristic life processes of all living things. Every living cell can perform each of them to a greater or lesser degree. If you will study an ameba (ȧ-mē′bȧ, see Fig. 7) under the microscope, you may observe all of these processes demonstrated in this typical one-celled animal.

Just to keep itself alive every cell of your body must take in food and oxygen, combine them, and eliminate the wastes. We use one word, *metabolism* (mĕ-tăb′ō-lĭz'm), to designate all these chemical changes within the cell relative to its use of food. Can you formulate a definition for "metabolism"?

Specialization among cells. The protoplasm in a one-celled organism [1] such as the ameba is self-sufficient; in a very simple fashion it is able to carry on all seven of the above-mentioned functions of life. In the many-celled individual, however, each cell specializes in performing certain limited functions for the body as a whole. For example, blood cells carry oxygen to all other cells; nerve cells convey messages; and muscle cells produce movement. Each cell specialist, however, must also carry on its own life processes with the aid and co-operation of other cells.

In the human body the division of labor among cells has brought about great differences in chemical composition and function. In order to perform their special tasks they also vary in size and shape. Figure 8 shows some of the variations in human cells. Can you explain why muscle cells are long and ropelike, while protective cells, *e.g.*, those lining your mouth, are flat and platelike?

How cells are grouped into tissues. The many activities of the complex human body require large numbers of cells working in groups for different purposes. A mass of cells of one type united to perform some particular function is called a *tissue.* Tissues are distinguished by, and named after, the kind of cells of which they are composed. Liver cells form liver tissue; brain cells, brain tissue. Figure 8 shows typical cells and their arrangement in various kinds of tissues. Study it with the following discussion:

Tissues may be classified into four main divisions:

1. *Epithelial* (ĕp′ĭ-thē′lĭ-ăl) *tissues:* Skin and membranes (cavity linings) protect organs and secrete liquids. *Serous membrane* which lines your chest and abdominal cavities secretes a thin liquid to lessen friction where the lungs and intestines rub against the walls while in action. Nasal cavities are lined with *mucous membrane*

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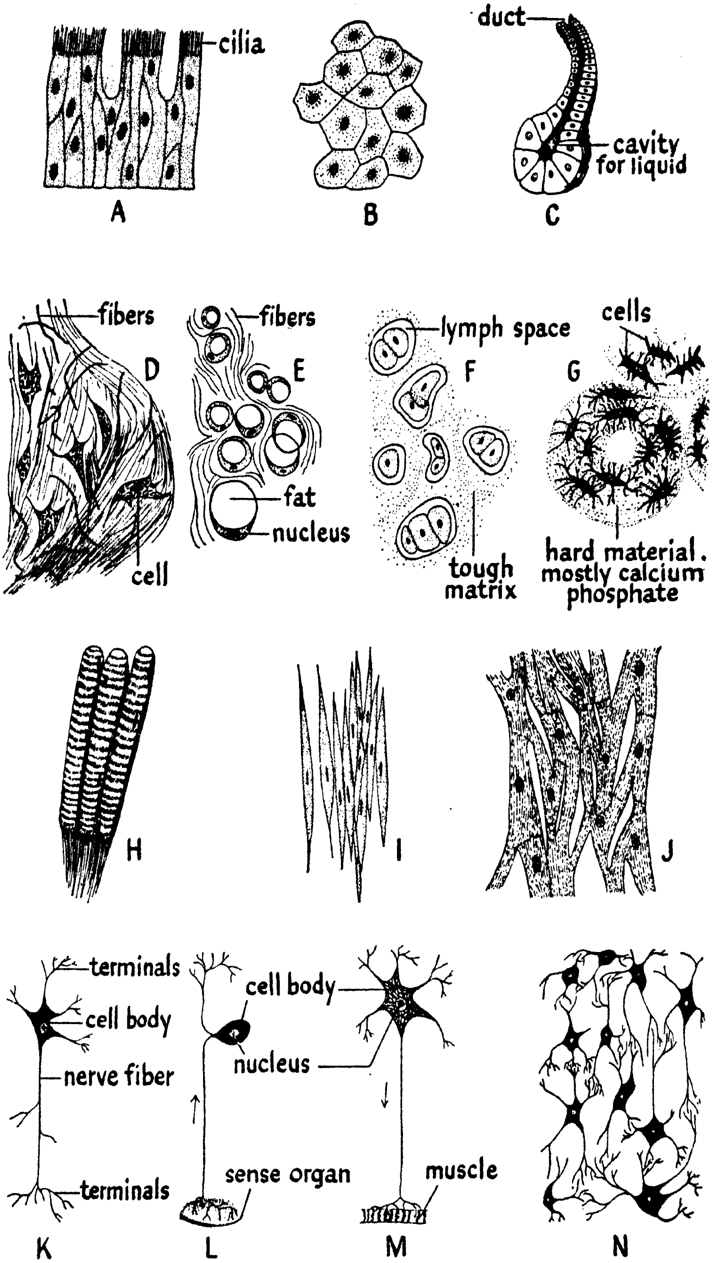
[1] Any living thing, plant or animal, is called an *organism.* Such words are defined in the Glossary at the back of the book. Make frequent use of it.

8 *Skin* (*epithelial*) *tissues* — for protection. Why are these cells close together? *A*. Lining of windpipe. Note cilia for fanning dust out of passages. *B*. Lining of mouth. *C*. Part of duct gland for secreting saliva or mucus.

Supporting tissues. These are strong because of the nonliving material between cells. *D*. Connective tissue — connects and holds organs together. Note tough fibers. *E*. Fat (adipose) tissue, as under the skin. *F*. Cartilage (gristle) — for padding between bones and in place of bone. The matrix is tough and flexible. Some cartilage has fibers also. Each cell floats in a lake of lymph for nourishment. *G*. Bone. Note cells with bony material between them. Here, also, each cell floats in a lake of lymph.

Muscle tissues — for movement. *H*. Skeletal muscle (as in arm). How is the shape of these cells especially suited to their function? *I*. Smooth muscle (as in intestinal walls). *J*. Heart (cardiac) muscle.

Nerve tissues — for transmitting messages. *K*. Typical nerve cell. *L*. Sensory nerve cell, for receiving messages in skin, eyes, etc. *M*. Motor nerve cell, for making a muscle work. *N*. Nerve cells forming part of the brain.


cilia
A
B
duct
cavity for liquid
C
fibers
D
cell
fibers
E
fat
nucleus
lymph space
F
tough matrix
cells
G
hard material, mostly calcium phosphate
H
I
J
terminals
cell body
nerve fiber
terminals
K
cell body
nucleus
sense organ
L
muscle
M
N

which secretes the mucus that is so annoying when you have a cold. Most interesting of all is the lining of your windpipe, which is called *ciliated* (sĭl′ĭ-āt′ed) *epithelium.* It contains tiny hairlike projections called *cilia* (sĭl′ĭ-ȧ). These cilia produce a constant fanning motion which carries dust and mucus upward and away from your lungs (Fig. 8, A).

2. *Supporting* (or *connective*) *tissues:* Bone and cartilage, blood and lymph, and connective tissue proper serve to support and connect other tissues. They have few cells and much nonliving material between the cells, as you will note in Fig. 8, parts D, E, F, and G.

Several varieties of connective tissue proper cover and protect organs, or connect them with each other. Most of these tissues contain tough fibers to give them strength, as in D. One type, *adipose* (ăd′ĭ-pōs) *tissue* shown in E, contains droplets of fat within the cells. This type is found under the skin, around joints, and in other places throughout the body. It protects the parts against jarring and heat changes and also furnishes the body with a reserve supply of fuel (fat).

3. *Muscular* (or *contractile*) *tissues:* Muscles contract or shorten, producing movement, and at the same time create heat.

4. *Nerve tissues:* The brain and nerves perform varied functions, such as thinking, receiving and transmitting sensations, and sending messages to muscles to contract.

How groups of tissues form organs. Just as cells are grouped together to form tissues, so tissues are associated to form *organs*, or structures adapted to some special function such as breathing, eating, thinking, etc. Most organs are exceedingly complex. Even an ordinary muscle contains muscular tissue to produce movement, nervous tissue to cause the muscle to act, connective tissue to bind the muscle cells together and hold them to the bones, and tiny blood and lymph vessels to carry food and oxygen to the cells and to remove waste materials.

How organs co-operate as systems. A group of organs working together to perform a general function is called a *system.* The many organs of the body are combined into nine main systems: (1) the circulatory, (2) the digestive, (3) the respiratory, (4) the excretory, (5) the nervous, (6) the endocrine (ĕn′dō-krĭn), (7) the reproductive, (8) the muscular, and (9) the skeletal. Remember that in no way are the different systems separate mechanisms; they are entirely interdependent and co-operative, working together to keep the individual alive. If any one of them fails to do its part, death usually follows.

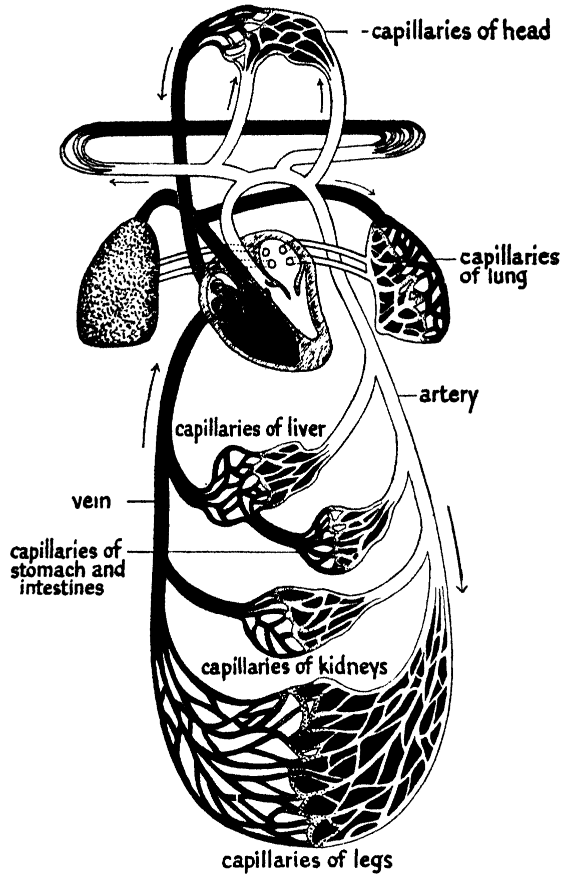
DISTRIBUTION OF LABOR AMONG THE SYSTEMS OF ORGANS

Your body is a most remarkable factory. Each system of organs acts as a department and performs certain functions for the good of the whole factory. The systems are not always found in separate compartments. Indeed, one organ may even be a part of two systems. All systems are closely interrelated and compactly arranged within the body cavities.

Now is the time for you to form a clear, but not too detailed, mental picture of the organs of your body and how they work together. In studying the rest of this problem, examine carefully all the diagrams mentioned and any similar ones available, especially wall charts. If possible, use a real skeleton and a model of a torso with removable organs, in order to become more familiar with and to locate every part mentioned. Try not to become too involved in details, however, as these will be studied later when each system is taken up separately.

1. The circulatory or transportation system. The blood is a carrier of food supplies and waste materials through a complicated network of connecting tubes called *blood vessels.* The same blood is pumped throughout the body repeatedly by the *heart.* Note in Fig. 9 that all the vessels in the system are hooked up in complete circuits; there are no "dead-end" tubes in it.

The blood is carried swiftly from the heart to all parts of the body in large vessels called *arteries.* These branch and rebranch until they form an amazingly fine network of tiny, thin-walled tubes called *capillaries.* After spreading out among the cells, the capillaries reunite to form large vessels called *veins*, which carry the blood back to the heart. Note in Fig. 9 that the heart pumps the blood to the lungs for a fresh supply of oxygen and then pumps it through the body again. Can you trace the path of a drop of blood throughout the entire circuit? No matter which path you take, do you always come back to the heart?



9 General scheme of the circulatory system. The arteries (light vessels in the above diagram) carry oxygen from lungs to cells; the veins (black vessels) carry carbon dioxide from cells to lungs.

In the capillaries, small amounts of the colorless part of the blood pass through the capillary walls and fill the spaces between and around the cells. (Note Fig. 39.) This watery fluid, called *lymph* (lĭmf), bathes the cells, and provides food materials and oxygen, which pass through the capillary walls and cell walls by osmosis. By the same method the cells discard their carbon dioxide and other waste products into the lymph. Part of this waste passes into the capillaries, but most of it is carried away by the lymph itself through a separate system of *lymph vessels* which unite from all parts of the body and finally empty back into the blood stream (see Fig. 36).

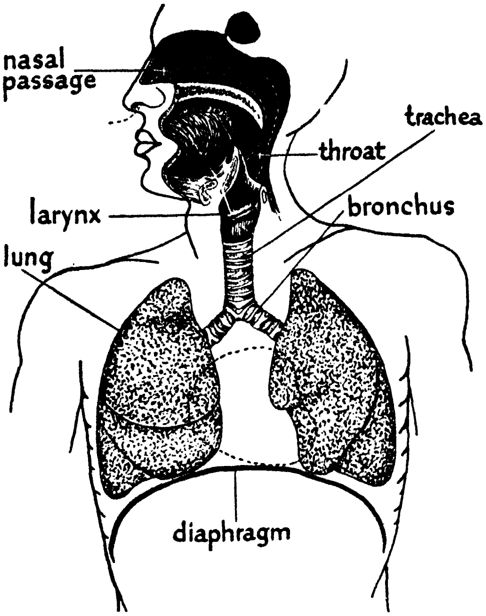
2. The digestive system. Digestion is primarily the changing of raw food materials into soluble form for use by the body cells. The various chambers in which the food is refined form a continuous tube called the *alimentary canal* (see Fig. 23). Here the food is put through a mechanical process of cutting and grinding, which is accomplished by the teeth and by muscles in the walls of the stomach and intestine, and a chemical process brought about by chemicals poured into the canal by glands along its course.

In Fig. 23 follow the course of the food through the *mouth,* down the *esophagus* (ē̇-sŏf′ȧ-gŭs), or gullet, to the *stomach*, and into the *small intestine* (ĭn-tĕs′tĭn), which is the most important section of the canal. In this 20-foot tube most of the work of digestion is performed and the digested materials are absorbed into the blood stream. The undigested parts then pass into the *large intestine* — the *colon* (kō′lŏn) — to be eliminated from the body.

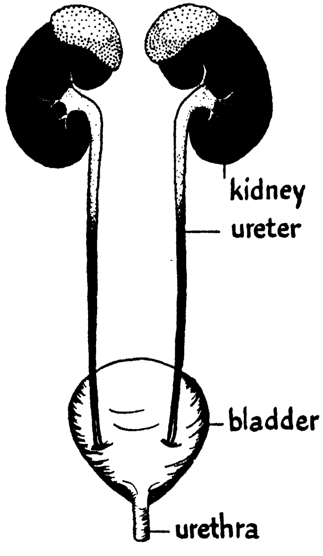
Along this tube are auxiliary organs, each with a specific duty to perform.. These are the *salivary glands*, *liver*, *gall bladder*, *pancreas* (păn′krē̇-ăs), and innumerable tiny glands in the walls of the stomach and intestines. The detailed story of digestion appears in Problems 3, 4, and 5.

3. The respiratory or breathing system. This is the most noticeably vital of all the systems, for if breathing ceases for even two or three minutes, you will become unconscious; and if it is not restored shortly, death ensues. This is because breathing performs two functions that are *constantly* necessary for the life of the cells: (1) it takes in and passes to the blood sufficient oxygen for all the body cells, and (2) it rids the blood of the carbon dioxide thrown off by all cells. If this waste accumulates in the blood and lymph, it quickly poisons the cells.

Figure 10 shows the machinery for performing these duties. Follow the path of the air through the *nose*, *throat*, *trachea* (trā′kē̇-ȧ) or windpipe, and *bronchial* (brŏn′kĭ-ăl) *tubes* to the *lungs*, where the oxygen is passed into the blood and the carbon dioxide received in return. The air is forced out the same path by certain muscles, particularly the *diaphragm* (dī′ȧ-frăm), which squeeze the lungs.



10 The respiratory system. Note that the left lung has two lobes, whereas the right has three.



11 The urinary organs. Their chief purpose is to control the body fluids.

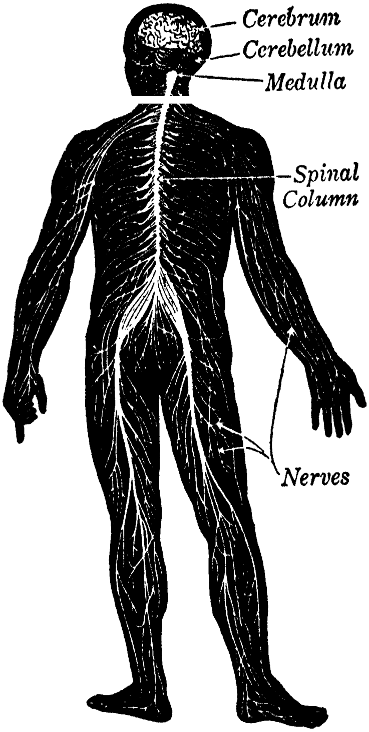
An extremely important accessory organ is the *larynx* (lăr′ĭngks), or voice box, which is situated at the top of the windpipe.

4. The excretory or cleansing system. This system may be defined as the sanitary department. It is not a connected series of organs, but a grouping of various separate units, each of which helps rid the body of some of its waste products. The colon has already been mentioned as eliminating undigested food materials. The other excretory organs strain the true wastes from the blood. These are the *lungs*, the *skin*, the *liver*, and the *kidneys* (Fig. 11).

5. The nervous or control system. Your body has a central control which (1) maintains contact with the outside world through *sensory nerves* connected with sense organs (eyes, ears, nose, tongue, and skin), (2) interprets messages received through the sense organs, and then

(3) does something about the situation, *i.e.*, responds to it by directing activity of muscles and glands by means of impulses sent through *motor nerves.*

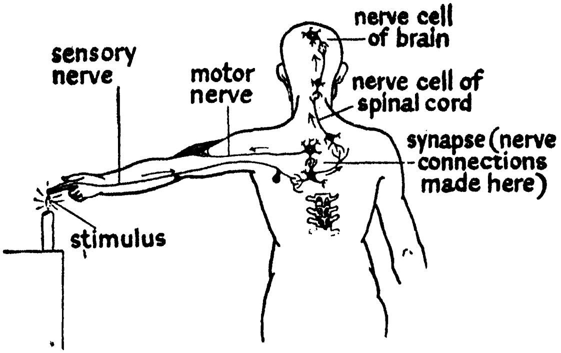
The whole control network is called the *nervous system* (Fig. 12). It consists of four main divisions: (1) the *sense organs* which pick up messages from outside; (2) *nerves* for carrying messages between the body and the brain; (3) the *central nervous system* (consisting of brain and spinal cord) which is the mechanism for thought, memory, all voluntary and reflex action, and all sense impressions; and (4) the *autonomic* (ô′tô-nŏm′ĭk) *nervous system* consisting of a chain of nerves located in *front* of the spinal column. This last system controls all vital body processes such as digestion, respiration, and circulation.



12 The general arrangement of the nervous system (viewed from behind), showing the brain, the spinal column, and the chief nerves that branch from it. (From Hough, Sedgwick, and Waddell, *Human Mechanism,* Second Revised Edition, Ginn and Company)

Anything which excites the tiny nerve endings in a sense organ is called a *stimulus.* Light, for example, stimulates the nerve endings in the eye and causes it to send a message or *nerve impulse* to the brain. Any movement resulting from a stimulus is called a *reaction,* as, for example, blinking because of a flash of light.

Actions performed consciously, under the direction of the brain, are called *voluntary* acts. Ordinarily, the brain interprets impulses from the senses and then sends other impulses to the organs whose activity will bring about an appropriate reaction. Other acts occur without the control of the brain. These are called *involuntary* acts. In emergencies, you sometimes react before your brain has received the message from the sense organs. For ex-

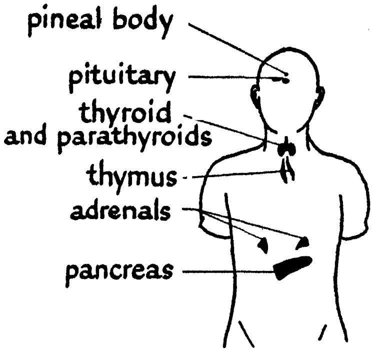

nerve cell of brain
sensory nerve
motor nerve
nerve cell of spinal cord
synapse (nerve-connections made here)
stimulus

13 A simple reflex act. Here the stimulus starts an impulse at the finger tip when you touch something. Impulse travels up the sensory nerve, makes connection with a motor nerve, and delivers message to the muscle before part of the impulse that went up spinal cord arrives at the brain. Hence the muscle moves before the brain knows what has happened.

ample, you jerk your hand away from a flame before you actually feel pain, for feeling takes place in the brain and the direct nerve connection was made in the spinal cord. Such reactions are called *reflexes.* Figure 13 shows how they occur. Study it carefully. Could you make a similar sketch to show the path of the nerve impulses by which you reflexly lift your foot when you step on a tack?

6. The endocrine system — more controls. Your endocrine glands are close allies of your nervous system and are truly the body's miracle workers. They are the regulators of all vital processes. The endocrine system consists of many *ductless glands* located in various parts of the body and ranging from tiny specks to organs the size of your hand (Fig. 14). These glands were little known until recently, yet they are responsible for stature, general build, texture of hair, vitality or rate of energy production, and, to a large extent, personality.

These organs exercise their tremendous power by means of specific chemicals called *hormones* which they manufacture and transmit to the blood by osmosis. They are called *ductless* because they have no ducts or tubes through which to discharge or *secrete* their fluids. When certain hormones are released into the blood, they sometimes produce an immediate and almost explosive reaction, such as violent anger. Most effects are slower, however, such as the control of bone growth throughout the entire period of childhood and adolescence. The functioning of these body regulators is so bound up with the nervous system that the two are often spoken of as the *neuroglandular* (nū′rō-glăn′dų̑-lȧr) *system.*



14 Endocrine glands. All these glands secrete directly into the blood, whereas other glands secrete into the lymphatics. (From Ella Thea Smith's *Exploring Biology*, Harcourt, Brace and Company)

7. The reproductive system. In the higher mammals, including human beings, nature has provided a marvelous system of organs to perpetuate the life of the race by bringing new lives into existence. The organs which produce the cells for the new life are known as *gonads* (gŏn′ăds), consisting of two *ovaries* (ō′vȧ-rĭz) in the female, and two *testes* (tĕs′tēz) in the male. These primary organs are supplemented by other organs necessary for the development of an infant. The gonads are also ductless glands which furnish the blood with chemicals extremely important in the development and maintenance of the body. These chemicals (hormones) are responsible for the characteristic physical and temperamental differences between men and women.

8. The muscular system. Whenever any movement takes place in your body, you can be sure that a *muscle* caused it. Muscles do not act of their own accord (except the heart muscle), but are stimulated either by an impulse from a nerve or a hormone from some gland.

The body contains about 500 muscles. These are grouped into three classes according to the type of cells and the kind of work they perform: (1) The *skeletal* (skĕl′ē-tăl) muscles (Fig. 81), which are attached to the bones by means of *tendons*, perform all external bodily movements. They are also called *voluntary* muscles because they are under direct control of the brain. (2) *Smooth* muscles, which are found in the internal organs, carry on all vital processes, such as breathing and digestion. They are also called *involuntary* muscles because they are controlled by the autonomic or self-regulating part of the nervous system. (3) The *heart* or *cardiac* (kär′dĭ-ăk) muscle is unique in that it contracts and relaxes automatically without stimulation from a nerve. Involuntary nerves, however, do regulate the rate at which it beats.

9. The skeletal system. As if loath to bring it from the closet, we have left the *skeleton* to the last. Yet it is the very framework around which all the rest of the body parts are constructed. The three important purposes of the skeleton are: (1) to make locomotion possible, for otherwise we would have to wriggle along like jellyfish; (2) to give support and shape to the body; and (3) to protect delicate organs like the heart and lungs. The skeleton is made up of some 206 separate bones held together at the joints by pieces of tough connective tissue called *ligaments.*

Summary. The human body is composed of 17 chemical elements. Energy can be derived from food only when it is combined with oxygen by the body cells. All life processes are carried on by the cells, each of which performs special functions. Every cell must have oxygen and food in soluble form so that it can absorb them by osmosis, and must be kept free of wastes.

Each system of organs performs certain functions for the whole body: (1) the *circulatory* system carries food and oxygen to cells and removes waste products; (2) the *digestive* system changes food to usable forms; (3) the *respiratory* system takes in oxygen and eliminates carbon dioxide; (4) the *excretory* system removes wastes from the blood and eliminates them from the body; (5) the *skeletal* system forms a framework to which muscles are attached; (6) the *muscular* system makes possible all bodily movement; (7) the *nervous* and *endocrine* systems stimulate and co-ordinate activities, and regulate all life processes; and (8) the *reproductive* system produces and nourishes cells for forming new individuals.

ACTIVITIES

1. Self-check on your study of this problem. See now if you can answer all the questions in the study outline of this problem. Discuss them in class. (Read again, Activity 1, page 15.)

2. Display of elements. From your chemistry department obtain a sample of each element in your body. Put each in a small glass bottle. Wire bottles to a cardboard and label properly. Use empty bottles to represent O, H, and N. **CAUTION.** *Before starting, read carefully **the instructions for handling chemicals*** in the Appendix.

3. Experiment on oxidation. Burn some common substances and observe the changes in matter and energy. Put 10 cubic centimeters of sulfuric acid (H_2SO_4 concentrated, see CAUTION in Activity 2) on about 40 grams of sugar and note results. The acid oxidizes the sugar by giving up enough O to combine with the H and O of the sugar. This forms H_2O which goes off in steam and leaves the pure C behind. Explain in each case: (1) how oxidation was the source of energy; (2) what waste products were formed; and (3) what energy transformation took place. In each case, trace the energy back to its original source, sunlight. Of what importance is oxidation in your body?

4. Observations with a microscope. View, sketch, and label several types of fresh live cells and prepared slides of cells. Good ones are: any thin green leaf such as elodea; thin layer peeled from inside section of onion; cells scraped carefully from the lining of your mouth with a toothpick and mounted in a drop of water; a drop of blood smeared thinly on a glass slide; prepared slides or extremely thin sections of animal tissue such as muscle, connective tissue, fat, liver, and skin.

5. Key words. These are especially important for this problem, as these terms will be found constantly throughout the remainder of this book and in reference reading. Do not try to learn them all at once; rather learn a few at a time and practice using them until you no longer have to stop to think what they mean. Keep them handy to refer to in your later study. Copy these words as the beginning of a permanent list in your notebook and write briefly your ideas (not merely a definition) about each:

SET I

matter
energy.
oxidation
atom
element
molecule
compound
photosynthesis
neutralize
osmosis
cell
protoplasm
metabolism
tissue
organ

SET II

respiratory
circulatory
excretory
endocrine glands
hormone
arteries
veins
capillaries
lymph
cerebrospinal
nervous system
sensory nerves
motor nerves
stimulus
nerve impulse
reflex act

6. A Professor Quiz review. Elect a member of your class as the "Professor" and one (or three) as judges (or let your teacher judge the answers and keep the score). Have each class member hand in 10 questions concerning this problem and let a committee select the best ones. Choose sides to compete in answering them. If well planned ahead of time and organized for orderly procedure, this activity can be very instructive as well as enjoyable. It can be used with any problem.

SUGGESTED REFERENCES [1]

Burkard, Wm. E., Chambers, R. L., and Maroney, F. W., *Health and Human Welfare,* Lyons and Carnahan, New York, 1937, pp. 109–121.

Gruenberg, B. C., *Biology and Human Life,* Ginn & Co., Boston, 1925, pp. 56–62, 126–129, 275–284.

Pieper, C. J., Beauchamp, W. L., and Frank, O. D., *Everyday Problems in Biology,* Scott, Foresman, and Co., New York, 1932, pp. 13–14, 33–34, 71–75.

Pieper, C. J., and Beauchamp, W. L., *Everyday Problems in Science,* Scott, Foresman, and Co., New York, 1935, pp. 140–158.

Watkins, R. K., and Bedell, R. C., *General Science for Today,* The Macmillan Company, New York, 1936, pp. 227–255, 455–469.

Webb, H. A., and Beauchamp, R. O., *Science by Observation and Experiment,* D. Appleton-Century Co., New York, 1935, pp. 481–524 (selected parts), 209–217.

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[1] You may have difficulty in doing extra reading on this problem *without going too much into detail.* The above references are of average high-school difficulty. You may also use any other high-school general-science or biology texts available. Look in the table of contents and index for topics such as those suggested by the *key words* for this problem.

Unit II. *Eating for Health and Vitality*

MOST young people, especially growing boys, take for granted that eating is necessary. At the first pangs of hunger they usually devour everything edible within sight. They rarely question what happens to food unless, perhaps, they wonder why their stomachs ache.

Animals and little children usually have appetites which are reliable guides to eating, but older children and adults often develop eating habits that make them insensitive to the needs of their bodies. People with poor skins, chronic colds, grouchy dispositions, and barrel-like or emaciated figures all give evidence that something is wrong with them. In many instances such conditions are traceable to errors in eating, for nutrition is the fundamental basis of physical existence.

Foolish are the gluttons who live to eat, and equally unintelligent are those who consider eating a necessary evil. History records that many great men have shortened their illustrious lives because of disregard for their bodily needs. At times everyone feels inspired to attempt great achievements, and in these exalted moments the thought of food seems unimportant. Nevertheless, high endeavor requires a perfectly functioning human machine which is reliable and will not break down under the stress of unusual effort. In the following three problems you will learn what foods your body needs and why, how to choose foods according to your needs, and what your body does with the food you give it.

Problem 3. *What Foods Do You Need?*

Man is what he eats. — LUDWIG FEUERBACH

STUDY OUTLINE

A. Your nourishment
  1. Is everything you eat a food?
  2. What kinds of things can nourish the body?

B. The food you need for energy
  1. What are calories?
  2. How many calories do we need daily?
  3. How are calories "counted"?

C. Body-building foods
  1. Of what is the body made?
  2. Do children need special foods for growth?
  3. Why do convalescents need special foods?
  4. What foods are needed to build blood? To build bones and teeth?

D. Food accessories essential for health
  1. How can foods have any effect on personality?
  2. Why have "deficiency diseases" increased in the last fifty years?
  3. What happens to a person if he doesn't get enough minerals? How can you tell whether you are getting enough? (See *Activity* 6, page 65.)
  4. Why is each vitamin so "vital"? How can you tell whether you are getting enough? (See *Activity* 6, page 65.)
  5. How can the amount of water anyone drinks affect his vitality?
  6. Why could you not live on concentrated foods?

"YOU can't get something for nothing" is more than a mere proverbial expression; it is a fundamental law of the universe. You cannot run an automobile without fuel nor can you make a good cake unless you put into it essential ingredients. This principle is sometimes known as "output = input," meaning that what you get out of anything must equal what you put into it. Scientists who have studied many phases of nature are convinced that this law holds true for mental and spiritual experiences as well as for physical ones.

The development of your body and the work it is able to do depend largely on the kind and quantity of the various substances you put into it. An athlete cannot have strong muscles and win victories unless his diet contains the elements that make for strength and endurance. Likewise you cannot win the particular race in life for which you are set unless your body has what it takes for that race.

YOUR NOURISHMENT

A century ago it was believed that one food was as good as another so long as it satisfied hunger. Now even little children are taught that milk and cod-liver oil help build straight and strong bones for them and that cereal gives them energy to run fast.

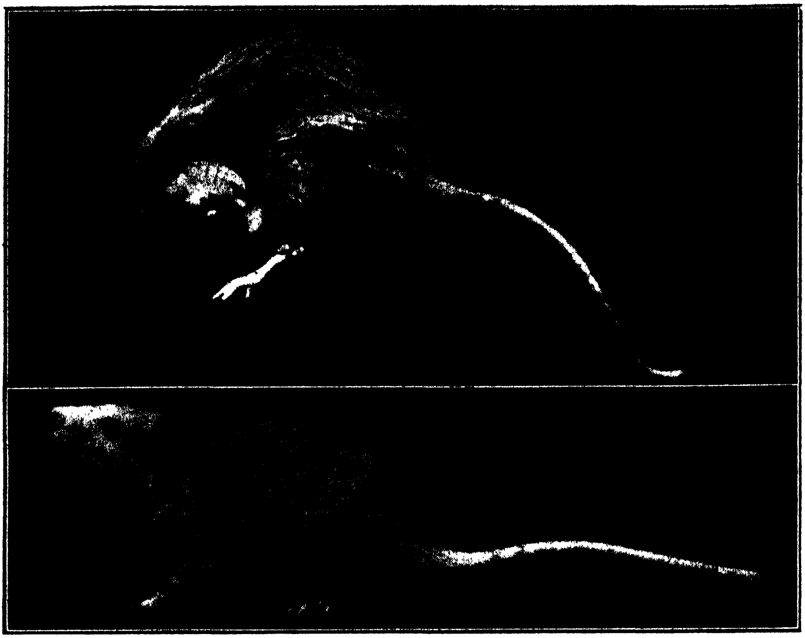
Why you eat. Science has shown that your body needs food for three specific uses. These are:

1. To furnish *energy* for heat, movement, and thought.
2. To help build body tissues for *growth* and *repair*.
3. To help in the chemical process of forming secretions necessary to *regulate body functions* and to *protect health.*

The building and regulating foods a person eats from early childhood have much to do with his growth, and with the development of his teeth, bones, nerves, glands, and all other vital organs. Likewise, the energy and protective foods he consumes daily are a primary determiner of his vitality, health, complexion, temperament, and innumerable traits that make up his personality. What anyone eats is so important that many experts feel as Savarin did when he said, "Tell me what you eat and I will tell you what you are."

The kinds of food you need. Modern laboratory tests have shown that for proper functioning of the body, every normal person needs all the different kinds of substances contained in the following classification. (As you study this outline, note foods rich in each factor as shown in the table, page 46):

1. *Carbohydrates — starches and sugars* (for energy). Elements are carbon, hydrogen, and oxygen in varying proportions. Found in grains, milk, potatoes, fruits, and vegetables.



15 Vitamin B_1 is necessary for good appetite, healthy nerves, and good muscle tone. The 24-week-old female rat (*above*) did not have enough vitamin B_1, and suffered from spastic paralysis (lack of nerve control of the muscles) *Below.* The same rat 24 hours later, after receiving food rich in vitamin B_1. Already it had recovered muscle control. (Courtesy of the United States Bureau of Home Economics)

2. *Fats* (for energy). Contain the same three elements as carbohydrates but produce two and a half times as much energy as the same amount of starches or sugars. Found in such foods as cream, butter, fat meats, nuts, and olives.

3. *Proteins* (for building, repair, and some energy). Contain the same elements as carbohydrates, plus nitrogen. Found in all animal foods such as lean meat, fish, chicken, eggs, milk, and cheese, and to some extent in most plant foods, especially nuts, peas, and beans.

4. *Minerals* (for building and regulating body functions). Include the elements calcium, phosphorus, chlorine, magnesium, potassium, iron, iodine, and small amounts of others. Found in combination with carbohydrates, fats, and proteins. Supplied by a wide variety of foods, the richest sources being vegetables, fruits,

milk and its products, egg yolks, whole-grain cereals, liver, and lean meat.

5. *Vitamins* (for regulating body functions, protecting health, and maintaining mental and physical vitality). Composed of organic substances other than carbohydrates, fats, or proteins, but found with them in fresh vegetables and fruits, milk, and whole-grain products. Absent from highly refined foods such as white sugar and white flour.

6. *Alkaline and acid residues* (for keeping the reaction of the body fluids nearly neutral). Composed of ash that remains when certain foods are oxidized in the tissues. Alkaline-forming foods are most fruits, vegetables, nuts, and milk. Acid-forming foods are meat, fish, poultry, eggs, and grain products.

7. *Fiber* (for stimulating the intestines). Composed of indigestible material in the husks and outer coats of grains, skins, seeds, and the framework of the stems and leaves. Best sources are fruits, vegetables, and whole-grain products.

8. *Water* (for dissolving substances to make chemical changes possible, eliminating waste products from the blood, flushing away food wastes in the intestines, helping to regulate temperature, etc.). Present to some degree in most foods.

Although most of our common foods contain several of the substances mentioned above, each is classed as a carbohydrate, fat, or protein, according to which of the three factors is present in greatest quantity. Bread, for instance, is called a carbohydrate food because it contains a high percentage of carbohydrate, as shown in the Table of Food Values on pages 46–51. Similarly, most vegetables are called carbohydrates, and meats protein.

All natural foods contain more or less carbohydrate, fat, or protein, and these three classes of food material may be thought of as "carriers" for vitamins and minerals. Fortunately, as seen from the table, most foods contain many nutritive substances and therefore serve several purposes. For example, an orange is considered a carbohydrate food because it contains much sugar, yet it also contains a good supply of calcium, phosphorus, iron, vitamin A, vitamin C, and some vitamins B and G.

Not all foods, however, contain a wide variety of nutritive factors, and many are almost wholly lacking in certain essentials,

TABLE I

A Table of Food Values

Compiled from information given in Bogert and Porter, *Dietetics Simplified;* Rose, *Foundations of Nutrition;* Rose, *Feeding the Family;* Sherman, *Chemistry of Foods and Nutrition;* Diehl, *A Textbook of Healthful Living.*

Explanation of the table:

XXXX = extremely rich source. XXX = excellent source. XX = good source. X = fair source.

o = contains some but very little of substance in question.

Blank space means none or information lacking.

For "excess acid," a dash is used instead of X.

Note: This system is based on a comparison of *equal weights* of all foods — not a comparison of common servings.

Food material	*Weight oz.*	*Common serving*	*Total calories*	*Protein*	*Fat*	*Carbohydrate*	*Minerals*			*Vitamins*				*Excess acid*	*Excess alkaline*
							Calcium	*Phosphorus*	*Iron*	*A*	*B*	*C*	*G*		
Almonds	0.5	12–14 nuts	91	XXX	XXX	X	XXXX	XXX	XX	X	XX				XXX
Apples, fresh	3.5	1 small 2″ diam.	63	o	o	X	o	o	o	X	XX	XX	XX		X
Applesauce	3.5	⅜ cup	124	o	o	XX	o	o	XX						X
Apricots, dried cooked	3.5	⅓ cup	128	X	X	XXX	XX	XX	XXXX	XXX					XX
Apricots, fresh	3.5	3 or 4 apricots	58	X	o	X	X	X	X	XXX		XX			
Artichokes	7.0	1,3″ diam. × 4″ long	125	X	o	X	o	X	X	XX	X				
Asparagus, fresh	3.5	12 stalks 5″ long	22	X	o	X	X	X	X	XX	XXX		XXX		X
Avocado	3.5	½ a large one	97	X	XX	X	XX	X	XXX	XXX	XXX	X	XX		
Bacon (lean) crisp	1.0	8–10 small slices	119	XX	XXX	o	o	XX	X	o–X	X–XX	o	XX		
Banana	3.5	1 medium	99	X	o	X	o	X	X	XX	XX	XX	XX		XX
*Beans, baked	3.5	½ cup	129	X	X	XX	X	XXX	X						XX
Beans, lima, fresh	3.5	⅝ cup	123	X	o	XX	X	X	XX	X	XX	X			XX
Beans, string, fresh	3.5	¾ cup	42	X	o	X	X	X	X	XX	XX	XX			XX
Beef, boiled	3.5	1½″ cube	307	XXX	XXX	o	o	XX	XX	X			XX	—	
Beef, round, lean	3.5	Piece 2½″ × 2½″ × ¾″	156	XXX	XX	o	X	XXX	XX	o–X	XX	o–X	XX	—	
Beef, roast	3.5	1 slice 5″ × 2½″ × ¼″	347	XXX	XXX	o	o	XXX	X	X	XX	o–X		—	

Beef steak, sirloin	3.5	Slice 2″×3″×2″	242	XX	XX	o	o	XXX	XX	X	XX			—	
Beets, fresh	3.5	½ cup, diced	46	X	o	X	X	X	o	X	XX	X	XX		XXX
Beet greens	3.5	½ cup, cooked	27	X	X	X	XX	XXX	XX	XX	XX		XXX		
Blackberries	3.5	¾ cup, scant	58	X	X	X	o	o	o			X			
Brazil nuts	3.5	20–22 nuts	697	XX	XXX	X	XX	XXX	X	X	XX	o			
*Bread, Graham 100%	1.0	1 slice 3″×3¾″×½″	74	XX	X	XXX	X	XXX	XX	X	XX	o	X	—	
*Bread, white	0.7	1 slice 3″×3½″×½″	52	X	X	XXX	X	X	o		X	o		—	
*Bread, whole wheat	1.0	1 slice 3″×3¾″×½″	70	X	X	XXX	X	X	X	X	XX		X	—	
Broccoli	3.5	⅞ cup, steamed	32	X	o	X	XXX	X	X	XX	XX	XX	XX		
Brussels sprouts	3.5	7 sprouts, 1½″ diam.	21	X	o	X	o	X	X	XX		X			
*Butter	0.4	1 square ¼″ thick	77	X	XXX	o	o	o	o	XXX	o	o	o	Neutral	
Buttermilk	3.5	½ cup, scant	36	X	o	X	XX	XX	o	X	XX	X	XXX		X
Cabbage, raw	3.5	1⅛ cup, chopped	32	X	o	X	X	X	X	X	XX	XXX	XX		XX
Cantaloupe	9.0	½ melon 4½″ diam.	47	o	o	X	o	o	o	XX	XX	XX	o		X
Carrots, raw	3.5	¾ cup (½″ cubes)	45	X	o	X	X	X	o	XXX	XX	XX	XX		XXX
*Cake, chocolate (without frosting)	0.9	Piece 2½″ × 2½″ ×⅞″	100	o	XXX	XXX									
*Cake, 1 egg	1.0	1¾″ cube	100	o	XX	XXX									
*Cake, white frosting	1.0	2½ tbsp.	100		o	XXX	o	o	o	o	o	o	o		
*Cake, fruit	1.0	Piece 2″×2″×⅜″	115	o	XX	XXX									
Cauliflower	3.5	1 cup, chopped raw	31	X	o	X	XXX	X	o	X	XX	X	XX		X
Celery	3.5	¾ cup ¼″ pieces	19	X	o	X	XX	X	X	o	XX	X			XX
Chard, Swiss	3.5	½ cup, steamed	38	X	o	X	XX	X	X	XX	X	X			XXX
*Cheese, American	0.9	1 slice 3½″× 3½″ ×⅛″	110	XXX	XXX	o	XXXX	XXX	X	XXX	X	o	X	—	
Cheese, Cottage	3.5	½ cup (5½ tbsp.)	110	XXX	X	X	XX	XXX	o	X	X	o	X		
Cherries, fresh	3.5	15 cherries ⅞″ diam.	78	X	o	X	o	o	o	XX	X	XX			
Chicken, stewed	3.5	Piece ⅜″×2½″×5″	110	XXX	X		o	XX	XX					—	
*Chocolate fudge	0.9	Piece 1½″×¾″×1″	100	X	XXX	XXX				o	o	o	o		
*Chocolate, milk	0.7	Piece 2¼″×1″×⅛″	100	X	XXX	XX									
*Chocolate pudding	3.8	½ cup, scant	200	X	XX	XXX									
Chocolate, unsweetened	0.2	1 tbsp., grated	29	XX	XXX	XX	XX	XXX	X	o	o	o	o		
*Cocoa made with milk	9.0	1 cup	240	X	XX	XX									
Cocoa powder	0.3	1 tbsp.	50	XXX	XXX	XX	XXX	XXX	X	o	o	o	o		
Cod-liver oil	0.4	1 tbsp.	99	o	XXX	o				XXXX	o	o	o		
*Cole slaw	2.8	1 cup	100	o	XX	X									
Cookies, Hermits	4.0	1 cookie 2″ diam.	40	o	XX	XXX									
Corn, canned	3.5	⅔ cup	98	X	X	XX	o	X	o	XX	XX	X	X	—	

TABLE I (*continued*)

Food material	*Weight oz.*	*Common serving*	*Total calories*	*Protein*	*Fat*	*Carbohydrate*	*Minerals*			*Vitamins*				*Excess acid*	*Excess alkaline*
							Calcium	*Phosphorus*	*Iron*	*A*	*B*	*C*	*G*		
Corn, fresh	3.5	½ cup or 2 ears 6″	101	×	×	××	o	×	o	××	××	××	××		
Cornflakes	0.9	1 cup	96	××	o	×××	o	××	××					—	
Cornmeal, yellow cooked	3.5	⅓ cup	59	×	o	×	o	××	o	×	×	o		—	
*Cornstarch, Blanc Mange	2.7	¼ cup	100	×	×	×××									
Corn syrup, Karo	0.4	2 tbsp.	136	o	o	×××									
Crackers, Graham	3.5	10 crackers	420	××	××	×××	o	××	×					—	
Crackers, soda	0.2	1 cracker	25	××	××	×××	o	×	×					—	
Cranberry sauce	1.5	¼ cup, scant	100	o	o	××	o	o	o	×	—	××	—		
Cream pie	3.2	10″ pie 2″ at rim	100	×	××	××									
*Cream, thick, 18.5%	0.6	1 tsp.	31	×	××	×	×	×	o	×	××	×	×××		
*Cream, very thick, 40%	0.6	1 tsp. or 1¾ tsp. whipped	61	×	×××	×	×	×	o	××	×	×	××		
Cucumbers	3.5	14 slices ⅛″ thick	17	o	o	×	o	×	o	×	×	××		—	•
*Custard	3.3	½ cup, scant	150	××	××	××									
Dandelion greens	3.5	1⅓ cup, steamed	52	×	o	×	×××	×	××	××	××	×	××		×
*Dates, dried	1.0	4–5 dates	98	×	×	×××	×	×	××	××	××	o	×		×××
Eggs, whole	1.8	1 egg	74	××	××	o	××	××	××	××	××	o	××	—	
Egg white	1.0	1 white	14	××	o	o	o	o	o	o	o			—	
*Egg yolk	0.6	1 yolk, avge.	58	××	×××	o	×××	×××	××××	×××	×××		×××	—	
Endive	3.5	2 stalks 5¾″ long	23	×	o	×	×××	×	o	××		×			×
*Farina, dark cooked	6.0	¾ cup	100	×			o	××	×		××				
*Figs, dried	3.5	6 medium	317	×	o	×××	×××	×	××	×					××
*Flapjacks	1.8	1 cake 4½″ diam.	100	o	×	×××									
Gelatin desserts	4.0	½ cup	100	o	o	××									
Grapefruit	7.0	½ large	70	o	o	×	×	×	o	×	××	×××	××		×
Grapefruit juice	3.5	⅜ cup, scant	27	o	o	×	o	o	o	×	××	×××	××		×
Grapes	3.5	20 grapes	96	×	×	×	o	×	o	×	×	×	×		×
Grapenuts	1.0	3 tbsp.	100	××	×	×××									
*Gravy (varies greatly)	1.0	2 tsp.	50	o	×××	×									
Halibut steak	3.5	Piece 3″×1¾″×1″	121	××	×		o	××	o	o	×	o	×	—	

Ham, lean	3.5	Piece 4¼" X 4" X 1" ⅛"	266	XXX	XXX		o	XX	XXX	—	X	—	XX	—	
Hamburger steak, broiled	2.0	Cake 2½" diam. ⅞" thick	100	XX	XX	o	o	XXX	XX	X	XX			—	
Heart, beef	3.5	Piece 2"X3"X1"	248	XX	XX	o	o	X	XX	X	XX	X	XXX	—	
Hominy, cooked	3.5	¼ cup	82	X	o	X	o	o	o	o		o			
Honey	1.0	1 tbsp.	93	o	o	XXX	o	o	o	o	o	o			
***Ice cream, vanilla**	3.5	½ cup	216	X	XXX	XX	XX	X	o	X	o	o	X		
***Jam**	0.6	1 tsp.	48	o	o	XXX									
***Jelly**	0.6	1 tsp.	43	o	o	XXX									
Kale	3.5	1⅛ cup, steamed	51	X	o	X	XXXX	X	XX	XXX	X	XX	XXX		
Kidney, veal	3.5	½ cup, cubed	125	XX	X	o	o	XX	XXX	XX	XX		XXX	—	
***Lamb chop**	1.0	1 medium	100	XXX	XXX		o	XXX	XX	o	X	o	XX		
***Lamb leg, roast**	2.0	Slice 3¾"X4½" X⅛"	109	XXX	XX		o	XX	X	o	X	o	XX	—	
Lemons	3.5	1 large lemon 2¾"	31	o	o	X	X	o	o	X	XX	XXX	XX		X
Lentils, dried uncooked	3.5	½ cup	349	XXX	X	XXX	XX	XXX	XXX	X	XX	o			X
Lettuce	1.7	3 large leaves	10	X	o	X	X	X	o	XX	XX	XXX	XX		X
Liver, beef	3.5	Piece 3"X3"X⅝"	129	XXX	X	X	o	XX	XXXX	XXXX	XX	X	XXXX		
Macaroni, cooked	3.5	½ cup	89	X	X	X	o	o	o	o	o	o	o	—	
Mackerel, fresh	3.5	Cross section 3½" on back	139	XX	X		o	XX	X						
***Mayonnaise**	0.5	1 tbsp.	100	o	XXX	o									
Milk, evaporated	2.1	4 tbsp., scant	100	XX	XX	X	XXXX	XX	o	XX	XX		XXX		X
***Milk, malted, dry**	0.3	1 tbsp.	35	XX	X	XXX	XXXX	XXX	X	XX	XX		XXX		
Milk, skimmed	8.5	1 cup	88	X	o	X	XXX	X	o	X	XX	X	XXX		X
Milk, whole fresh	8.5	1 cup	169	XX	XX	X	XXX	XX	o	XX	XX	X	XX		X
Molasses	0.8	1 tbsp.	66	X	o	XXX	XXXX	X	XXXX	o	X	o			XXX
Mustard greens	2.6	½ cup	20	X	o	X	XXXX	X	XXX	XX	X	X	XXX		
***Oatmeal, cooked**	7.9	1 cup	100	X	X	XXX	XX	XXX	XX	X	XX	o		—	
***Oleomargarine**	0.5	1 tbsp.	97	X	XXX	o				o–XX	o	o	o		
***Olive oil**	0.5	1 tbsp.	126	o	XXX	o				o–X	o	o	o	Neutral	
***Olives, ripe**	1.0	3–5	71	X	XXX	X	XXX			X					
Onions	3.5	1 large	50	X	o	X	X	X	o	X	X	XX	X		X
Orange juice	3.5	½ cup scant	43	o	o	X	X	o	o	XX	XX	XXX	XX		XX
Oranges	3.5	1 small 2½" diam.	51	o	o	X	X	X	o	XX	XX	XXX	XX		XX
Oysters	3.5	⅓ cup (4–6)	50	X	X	X	X	X	XXX	XX	XX	X	XX	—	
Parsnips	3.5	½ cup, cubes	65	X	o	X	X	X	o	X	X				
Peaches, fresh	3.5	1 medium	41	o	o	X	o	XX	o	XX	XX	XX			X

TABLE I (*concluded*)

Food material	Weight oz.	Common serving	Total calories	Protein	Fat	Carbohydrate	Minerals			Vitamins				Excess acid	Excess alkaline
							Calcium	Phosphorus	Iron	A	B	C	G		
*Peanut butter	0.6	1 tbsp., scant	97	XXX	XXX	X	XX	XXX	X	X	XX		X	—	
*Peanuts	0.3	2 tbsp., 18 kernels	100	XXX	XXX	X	XX	XX	X	X	XX	o		—	
Pears, canned	3.5	2 halves and juice	76	o	o	X	o	o	o	X	XX	X			X
Pears, fresh	3.5	1 large	63	o	o	X	o	o	o	X	XX	X	XX		X
Peas, dried split	1.0	2 tbsp	101	XX	o	XX	XX	XXX	XXX	XX	XX		XXX		X
Peas, fresh	0.7	¼ cup	34	X	o	X	X	X	X	X	XX		X		X
*Pecans	1.0	⅙ cup	208	X	XXX	X	XX	XX	X	X	XX	o			
Peppers, green	3.5	2 medium	26	X	o	X	o	o	o	XXX	XX	XXX			
*Pie, apple	1.6	Piece 1½ circumference	100	o	XX	XXX									
Pie lemon	1.0	Piece 1½ circumference	100	X	XX	XXX									
*Pie, mince	1.2	Piece 1½ circumference	100	X	XX	XXX									
Pineapple, canned	3.5	½ cup or 2 small slices	153	o	o	X	o	X	o	XX	XX	X			
Plums, fresh	3.5	3 medium	84	X	o	XX	o	o	o						
Pork chop, lean	3.5	1 large chop	158	XXX	X	o	o	XXX	XX		XX	o	XX	—	
Pork roast, lean	3.5	1 slice 4″×3″×1″	202	XXX	XX	o		XXX	XX					—	
*Pork sausage	1.3	2 sausages 2″ long ¾″ diam	120	X	XX	o									
Potato chips	0.6	8–10 large pieces	100	o	XXX	XX									
Potato salad	3.5	1 serving	200	o	XX	XX									
*Potatoes, sweet	3.5	1 small	123	X	o	XX	o	X	o	XX	XX	XX			XX
*Potatoes, white	3.5	1 medium	100	X	o	XX	o	X	X	X	XX	XX	X		XX
Prunes, cooked	3.5	3 prunes and juice	139	X	o	XXX	X	X	XX	XXX	XX	o			
Puffed wheat	1.0	1⅔ cup	100	XX	XX	XXX	X								
Radishes	3.5	10 red button	29	X	o	X	X	X	o	X	XX	XX			X
Raisins, seeded	2.5	½ cup	245	X	X	XXX	X	X	X	o	X	X			XXX
Raisin pie	3.2	10″ pie 2″ at rim	200	o	XX	XXX									
Raspberries, fresh	4.8	1 cup	88	X	X	X	X	X	o	XX	X	XXX			X

Raspberry sherbet	2.1	1/4 cup	100	o	o	XXX									
Rhubarb, fresh	1.8	1/2 cup	12	o	o	X	X	X	X			X			XX
*Rice, brown, uncooked	3.5	1/2 cup	351	X	o	XXX	o	XX	X	X	XX	o	X	—	
*Rice pudding		1/2–1/4 cup	100	X	X	XXX									
*Rice, white, boiled	3.5	1/2 cup	93	X	o	XXX	o	X	o	o	o	o	o	—	
Rice, puffed	0.4	1/2 cup	37	XX	o	XXX	o	o	o	o	o	o	o		
Rutabagas, fresh	3.5	2/3 cup, cubes	41	X	o	X	X	X	o	X	XX	XXX			XX
Salmon, canned	1.8	1/2 cup	132	XXX	XX		o	XX	X	X			XX	—	
Sardines, canned	3.5	10–3″ long	269	XXX	XXX		X	XXX	X					—	
Sauerkraut	3.5	2/3 cup, solid	27	X	o	X	X	X	X	X	X	X			X
Spaghetti, cooked	3.5	1/2 cup	80	X	o	XX	o	o	o					—	
Spinach, cooked	3.5	5/8 cup, chopped	24	X	o	X	XX	X	XX	XXX	XX	XXX	XX		XXX
Squash, winter	3.5	1/2 cup, mashed	46	X	o	X	o	o	o	XX					X
Squash, summer	3.5	1/2 cup, mashed	16	X	o	X	o	o	o						
Stew with vegetables	8.0	1 cup	100	XX	XXX	XXX									
Strawberries, fresh	3.5	1/2 cup, mashed	39	X	o	X	X	X	o	X	X	XXX			X
*Sugar, granulated	0.5	1 tsp.	52	o	o	XXX	o	o	o	o	o	o	o	Neutral	
*Tapioca, cooked, cream	5.25	1/2 cup	83	o	X	XX	o	o	X	o	o	o	o	Neutral	
Tomato soup, cream	3.5	3/8 cup	100	X	XX	X	o	X	o	XX	XXX	XXX			X
Tomatoes, fresh	3.5	1 small	23	o	o	X	o	o	o	XX	XX	XXX	XX		X
Tomatoes, canned	3.5	1/2 cup	23	X	o	X	o	X	o	XX	XX	XXX	XX		X
Tuna fish, canned	3.5	1/2 cup	278	XXX	XXX		o	XX	X		X	—	XX		
Turkey meat	3.5	4″×3″×1/2″	100	XXX	X		o	XXX	XXX	o	X	o	X	—	
Turnip greens	3.5	3/4 cup, steamed	29	X	o	X	XXXX	X	XXXX	XXX	XXX	XX	XXX		
Turnips	3.5	3/4 cup	39	X	o	X	XX	X	o	X	XX	XX	XX		X
Veal roast, lean	3.5	2″×2 3/4″×1/4″	157	XXX	XX		o	XX	XX	o	X	o	XX	—	
Vegetable soup	3.5	1/2 cup, scant	43	X	o	X	o	X	X						X
Waldorf salad	3.0	1 serving	200	o	XXX	X									
*Walnuts, English	3.0	1 cup, chopped	600	XX	XXX	X	XX	XX	XXX	X	XX	o		—	
Watercress	3.5	1 bunch	22	o	o	X	XXX	o	X	XXX	XX	XXX	XX		
Watermelon	3.5	Piece 2 1/4″×2 1/2″ ×1″	30	o	o	X	XXX	o	X	XXX	XX	XXX	X		X
Wheat flakes, cooked	3.5	1/2 cup	59	X	o	X	o	o	o	X	X	XXX	X		
Wheat germ	1.0	3 tsp.	99	XX	X	XXX	X	XXX	o	XX	XXXX	o	XX		
Wheat, puffed	1.8	1 cup	187	XX	X	XXX	o	X	XXX	o	XXX	o	X	—	
Wheat, shredded	1.0	1 biscuit	100	XX	X	XXX	X	XXX	XXX	X	XXX	o	X	—	
Whitefish	3.5	2″×3″×1″	150	XXX	X		o	XX	X					—	
Yeast	0.5	1 cake	21	XX	o	X	o	o	o	o	XXX	o	XXX		

particularly vitamins and minerals. Hence in spite of the vast array of available foods, many people are below par in health because of some deficiency in diet. In order to make your diet fulfill *all* your food needs, you will want to know the general composition of specific foods and the purposes they serve, as explained in the remainder of this problem.

THE FOODS YOU NEED FOR ENERGY

The amount of gasoline needed to run an automobile varies according to the weight of the car and its load, the mechanical condition of the engine, the grades in the road, and other factors. Just so does a human being's fuel requirement vary with his age, sex, height, weight, area of body surface, amount of exercise, temperature of surroundings, nature of clothing, and mental and physical health. Obviously, then, all people do not need the same amount of food, nor does one person need the same amount at all times.

How calories are measured. Measuring silk by the yard and sugar by the pound is a common experience, but measuring energy by the calorie[1] is not so familiar to most people. The term "calorie" expresses a definite amount of heat energy. To say that a slice of bread yields 70 calories means that when it is "burned" by the body cells (or in any other way), its chemical energy will be converted into 70 calories of heat energy.

The caloric value of food is measured in a heat-tight box called a *calorimeter*. The walls are hollow and a measured volume of water is circulated through them. A known quantity of food is burned in the inner chamber by means of an electric fuse, and the calories are calculated by measuring the amount of heat that passes into the water.

To measure the calories burned in the body, scientists use a device which looks like a gas mask. As a person breathes through it, it measures the amount of oxygen he takes in and the carbon dioxide he exhales in a given time. Since chemists know the amount of oxygen required to set free a calorie of heat energy, it is then a simple matter to compute the number of calories the person burned.

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[1] A food calorie is defined as the amount of heat required to raise the temperature of 1 kilogram of water 1° C. which is nearly the same as raising the temperature of 2 quarts of water 1° F. The small calorie used in many scientific measurements is $\frac{1}{1000}$ of this amount.

Energy needed varies with activity. During complete rest the cells are not burning fuel very fast. The number of calories the body needs under such conditions is called *basal metabolism.* If a person is healthy, he should use for this purpose, in 24 hours, about 11 calories for each pound of his normal weight (that is, normal weight for his age and height).

In addition to basic requirements, you need varying amounts of energy for different kinds of activities. Note in Table II, below, how the calories needed (column A) increase as activity becomes more strenuous.

How to determine the calories you need. You may calculate the number of calories you need according to your weight. For

TABLE II

Method of Calculating Daily Calorie Needs for Normal Individuals

	A		B		C
Activity	*Calories per pound per hour*	×	*No. of hours*	=	*Calories per pound per day per activity*
1. Sleeping	0.43	×	(9)	=	(3.87)
2. Awake, lying still	0.50	×	(0)	=	(0.00)
3. Sitting quietly	0.65	×	(2)	=	(1.30)
4. Sitting at work and meals	0.70–1.00 (0.85)	×	(7)	=	(5.95)
5. Light exercise (walking slowly)	1.00–1.30 (1.20)	×	(2)	=	(2.40)
6. Moderate exercise (housework, carpentry, gardening)	1.60	×	(1)	=	(1.60)
7. Active exercise (walking fast)	1.90	×	(1)	=	(1.90)
8. Severe exercise (wood chopping, basketball, etc.)	3.70	×	(2)	=	(7.40)
	Total		24		
Total calories expended per pound per day				=	(24.42)

Then

Body weight × total calories expended per pound = calories needed daily
130 (pounds) × 24.42 (calories) = 3174.60 (calories)

each pound of body weight, boys 14 to 25 years old require about 27 to 18 calories per pound daily, while girls of the same age need 23 to 16 calories per pound. The number of calories needed per pound decreases as age increases. Choose a larger or smaller number according to your age and activities. Then merely multiply it by your weight. For example: A boy 17 years old who weighs 130 pounds, walks a mile to and from school, and plays football for two hours a day, probably uses the maximum calories per pound for his age. From the choice of 27 to 18, let us estimate his needs at, say, 26 calories per pound. Multiplying this by his weight (26 × 130) gives 3,380 calories used by his body daily.

You may calculate your daily calorie needs also as directed in Activity 5, page 65, and illustrated in Table II. The numbers in parentheses there show how to calculate the needs for the same boy mentioned above.

The amount of energy foods (carbohydrates and fats) you need. The amount of starches and sugars recommended for the average diet should constitute about two thirds of the total calories, and fats about one sixth. Rich sources of the three types of energy foods are:

Sugars: Pure sugars; honey, molasses, syrups, candies, cocoa, chocolate, jams, jellies, and fruits (dried, fresh, or canned).

Starches: All grains and products made from them — flour, breads, cereals, cakes, pastries, macaroni; or some vegetables — potatoes, beans, peas, parsnips.

Fats: Butter, oleomargarine, all cooking fats and oils, salad dressing, cream, nuts, bacon, cream cheeses, egg yolk, cocoa, and chocolate. Moderately rich foods are fat meats and fish, olives, avocados, ice cream, pastries, some cakes, cookies, and doughnuts.

Most sugars and starches are incomplete foods, very low or almost lacking in proteins, vitamins, minerals, and fiber. You will need plenty of milk, fruits, and vegetables to balance them. An excessive amount of starches and sugars is apt to crowd out the other foods you so vitally need and to result in constipation, indigestion, and skin troubles, particularly in the "teen age." Authorities agree that candies, ice cream, and other sweets should be avoided between meals, because they satisfy appetite quickly. High-school boys and girls need a good appetite for the wholesome foods necessary for healthy growth. Too much fat should also be avoided for reasons explained on page 99.

BODY-BUILDING FOODS

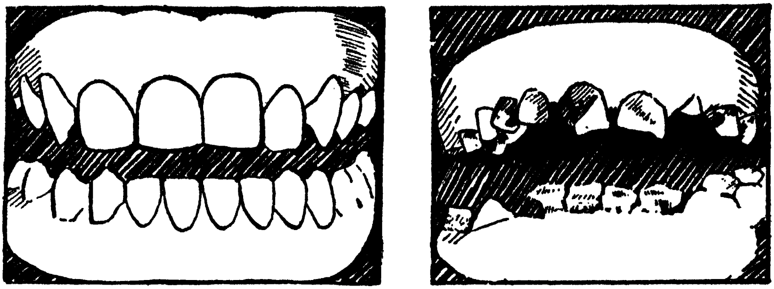
The human house is never completely built and finished. Certain parts are constantly being torn down and rebuilt. The outer skin cells are continually sloughing off to be replaced by new ones. Both growth and repair require the formation of new cells. This necessitates specific amounts of the following building materials daily:

Proteins for growth and repair. Most body tissues such as muscles, vital organs, and skin are built of proteins. Proteins are made of nitrogen-containing elements called *amino* (ăm′ĭ-nō) *acids*, some 22 in number. Those proteins which provide all the amino acids needed for repair and growth are called *complete* proteins. These are found in milk, cheese, eggs, meat, and most nuts. Proteins of poorer quality are said to be *incomplete;* examples of them are found in peas, beans, and other legumes, cereals, and gelatin.

The body requires a large variety of proteins but needs only a small quantity of each. Moreover, since it cannot store them for future use, any excess amounts place additional eliminating work on the liver and kidneys. The amount of protein usually recommended for a normal diet is about 15 per cent of the total calories, for children, 10 per cent for adults. Can you explain why the proportion is greater for children? (*Hint:* For what purpose does the body use proteins?)

The protein needed daily by a child is easily furnished by a quart of milk or by a combination of a pint of milk, an egg yolk, some cottage cheese, and cereal. An adult will need two glasses of milk, one egg, and one serving of meat or other *protein-rich* food indicated by "× × ×" in Table I, pages 46–51.

Iron for red blood. Iron exists in all of the cells, but is most important in the red corpuscles. If the required amount (which is less than the weight of a cent) is even slightly decreased, the red corpuscles cannot transport enough oxygen to the cells of the body.



16 The effect of diet on tooth-building. *Left.* Sound, well-constructed teeth of a boy of 15 years who had the proper tooth-building materials. His mother's diet during his prenatal life was well balanced, and his first teeth were sound. *Right.* Porous, soft, decayed, irregular teeth of a boy of 10 years who never had the proper tooth-building materials. His mother's diet during his prenatal life was deficient, and his first teeth were poor. (Drawings adapted from photographs furnished by the Forsyth Dental Infirmary for Children, Boston, Massachusetts) (For complete discussion of tooth care, see also pages 211–215.)

This condition — known as *anemia* — causes a person to become pale, weak, easily tired, short of breath, and generally slowed down.

In order to make use of iron the body apparently requires also copper, vitamins, and other essential elements. Although a number of foods contain iron, it appears that the best sources are dark-colored foods, chiefly liver, kidney, chicken gizzards, eggs, lean meat; and fruits, especially apricots, peaches, prunes, and raisins. For other good sources of iron, see Table I, pages 46–51.

Calcium and phosphorus for strong teeth and bones. These two minerals, combined as calcium phosphate, make teeth and bones hard and strong (Fig. 16). Phosphorus is needed also for the nuclei of cells and for brain and other nerve tissues. Lack of either of these two elements or of vitamin D produces nervousness and causes growing children to have *rickets*, a disease in which the bones are soft and poorly formed. "Pigeon chest" and bowlegs or knock-knees often result from rickets — deformities preventable by proper diet.

Rich supplies of these two minerals are furnished in foods such as milk, cheese, egg yolk, dried beans and peas, and cocoa. The best source of calcium is milk. The calcium in milk is in a more usable form than in any other food, and it is for this reason that dietitians recommend a pint of milk daily for all normal persons. Anyone who is allergic (see page 424) to milk must be particularly careful to get an abundance of other calcium-containing foods. For other sources of both calcium and phosphorus, see Table I, pages 46–51.

FOOD ACCESSORIES ESSENTIAL FOR HEALTH

You know that an automobile is useless without oil and grease even though it has plenty of gasoline. You may fail to realize, however, that your own mechanism also needs more than just fuel (calories). From the White House Conference on Child Health and Protection it has been estimated conservatively that "at least 30 per cent of the population of this country are victims of malnutrition" and that "the truth is that frequently we find malnutrition even to a greater degree among the well-to-do and the wealthy" (than among the poor).[1]

The things people most often omit from their diets are *minerals* and *vitamins* — those infinitesimal particles with gigantic power to build vitality and protect health! People are also likely to overlook the importance of *water* and *fiber* as regulators of blood chemicals and body processes.

Minerals for good health and personality. Experiments have shown why you must have minerals in your food. For example, when a frog's muscles are bathed internally in a dilute salt solution, they cannot be made to contract. When calcium is added, the muscles recover. We conclude that without calcium in the blood you would be unable to move, and with an inadequate supply of it you would lack muscular tone, or readiness for action.

Similarly, nerves cannot carry messages unless they are supplied with a solution of calcium, potassium, and sodium. When the amount of these minerals is reduced, a person becomes nervous and irritable.

Other important functions of various minerals can only be mentioned here, such as: Clotting blood to stop bleeding; keeping the blood neutral (*i.e.*, neither acid nor alkaline); controlling the movement of liquids in the body by the process of osmosis; aiding in the secretion and action of digestive juices; helping to regulate the vital processes of burning fuel, secreting wastes, growing, and reproducing; and preventing such deficiency diseases as *goiter* and *anemia*.

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[1] Barnett Sure, *The Little Things in Life*, D. Appleton-Century, New York, 1937, p. 130.

How to get your mineral supply. Nature has combined all the 14 or more minerals indispensable to us in such a way that if we are careful to have an abundance of iron, calcium, phosphorus, and iodine, we may be fairly sure we are getting enough of the others also. Rich sources of the first three minerals mentioned have been given (pages 55, 56). Iodine is found in sea foods, drinking water, and locally grown fruits and vegetables in most places. In the inland mountainous sections and northern half of the United States, however, iodine is scarce. The result is that goiter is prevalent in these areas, which are known as "goiter regions." People living in these localities should eat plenty of canned or frozen sea foods (since they can get none fresh) and should use iodized table salt, if approved by their physician.

To get sufficient minerals eat habitually according to "Your Health Habits," page 66. Children need two to four times as much of the mineral elements in relation to their weight as adults. Their diet, therefore, should contain a larger proportion of mineral foods, especially milk (at least a pint daily).

Why vitamins are vital. The vitamins have been given so much publicity since their discovery that you may think they are merely sales-promoting fantasies. Or you may have read stories of how the lack of vitamins caused terrible diseases among ancient oriental peoples and dungeon prisoners. These stories may have made you think that vitamin deficiencies are very distant and unimportant in your own life.

Every one of the vitamins has helped in your growth and continuously plays an essential part in regulating your body functions and your personality. If you have not had quite enough of one or more of them since babyhood, you have not developed quite perfectly. If you are not now getting enough, you may be below the level of your highest possibility of buoyant health and keen-mindedness.

These facts are known chiefly from experiments on feeding animals and people on specific diets, and from studies of various diseases. Some diseases are due to a lack, or *deficiency*, of certain vitamins. They are cured easily by adding an adequate supply of the deficient vitamins.

Vitamin A is especially necessary for *growth and repair.* It is believed to be essential for converting food into living substance. Hence an inadequate supply of it is followed by a slowing down of growth or by an underweight condition. Vitamin A also helps to keep the *skin* and *mucous linings* of the throat, nose, eyes, and other organs in good condition. If these membranes are healthy, they are less susceptible to germ attack and you are probably less likely to have colds.

A lack of vitamin A is indicated by such eye weaknesses as poor adaptation to dark, a strong aversion to light, "granulated eyelids," severe burning and itching, or excessive dryness and redness of the eyelids. Such eye troubles have been common, especially in children, during war times when diets are limited. It was prevalent among children of Scandinavia during the first World War because most of their butter (their chief source of vitamin A) was shipped to the German soldiers.

The substance in which vitamin A has its origin is *carotene,* an orange-yellow coloring matter present in all green plants and stored in carrots, oranges, and other plants with yellow parts. Animals and fish get carotene from plants and store it in concentrated form in their livers. Our best sources of vitamin A are cod- and halibut-liver oils, animal liver, and yellow- or green-colored foods.

Vitamin B was the first to be discovered. Then it was thought to be *one* substance, important for healthy nerves. Later it was found to be a "complex" of several different substances, now called vitamins B_1, B_2, etc., each producing specific effects.

A series of investigations by workers in the field of comparative psychology has shown strikingly that a deficiency of vitamin B complex predisposes to diseases of the nervous system. Even the ability to think and learn quickly, especially in the formative years, seems to depend to some extent upon an ample supply of this vitamin. Groups of young rats fed extra quantities of vitamin B show 50 per cent greater ability to learn than equivalent groups fed a normal, balanced diet.[1]

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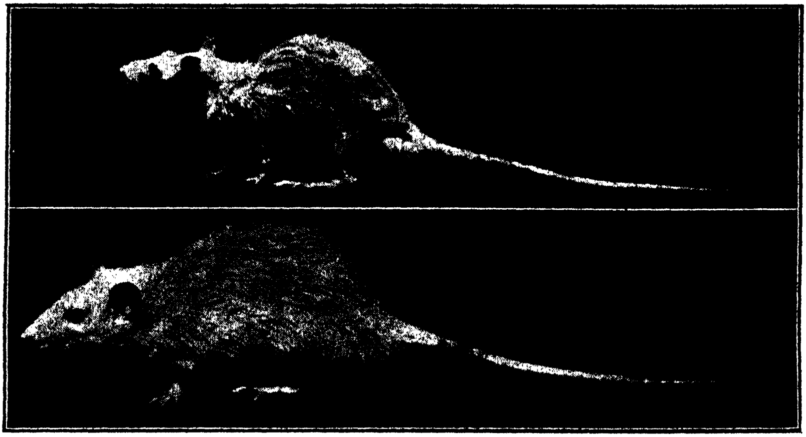
[1] Maurer, S., "The Effect of Partial Depletion of Vitamin B(B_1) Upon Performance of Rats," *Journal of Comparative Psychology,* 1935, vol. 20, pp. 385–387.



17 Vitamin G is important for general well-being. The 28-week-old male rat (*above*) had no vitamin G and weighed only 63 grams. Note loss of hair and emaciated condition. *Below.* The same rat 6 weeks later, after receiving food rich in vitamin G. Its weight was then 169 grams. (Courtesy of the United States Bureau of Home Economics)

Vitamin B_1 promotes *growth*, stimulates the *appetite*, tones up the *intestinal tract*, helps maintain a *good complexion*, and is especially important for *healthy nerves* (Fig. 15). Indeed, it is sometimes called "the nerve vitamin" because a lack of it causes *polyneuritis* (pŏl′ĭ-nū-rī′tĭs) or *beriberi* (bĕr′ĭ-bĕr′ĭ), a nervous disorder that causes paralysis and death. This disease used to be prevalent among oriental people, who lived mostly on polished rice. In 1897 Dr. Christian Eijkman, a Dutch physician, discovered that the outer coats of rice would prevent or cure the disease, but the food factor concerned was not known to be a vitamin until 1911. Since then it has become increasingly appreciated as a nourisher of nerves, and now huge doses of it are used successfully to cure certain types of nervous heart conditions and even insanity.

Other facts important to know about vitamin B_1 are: (1) high temperatures destroy it; and (2) it may be dissolved in the water in which foods are cooked. How could you save vitamin B_1 in foods?

Our best sources of vitamin B_1 are yeast, wheat germ, whole-grain breads and cereals, egg yolk, and some fresh vegetables (see Table I, pages 46–51).

Vitamin C is especially necessary for healthy *skin* and *teeth*. It is also vital for *growth*, and for the health of the *bones*, *blood* *vessels*, and *connective tissues*. Its prolonged deficiency causes *scurvy*, a disease of the skin, gums, and bones. This once was a common cause of death on shipboard during long voyages without fresh fruits or vegetables. One discerning old sea adventurer, Captain Cook, found that his men did not get scurvy when he took along several barrels of sauerkraut and rationed it wisely. Later it was discovered that citrus fruits would prevent scurvy. The English navy immediately supplied her ships with "limes" (our present-day lemons), and to this day her sailors are nicknamed "Limies."

Small children are now given orange or tomato juice daily, principally for vitamin C, which is so necessary for proper development of teeth and bones. In spite of the ease with which vitamin C prevents and cures scurvy, this disease is still common in some localities where food sources of vitamin C are used only sparingly.

Our richest sources of vitamin C are (1) citrus fruits (lemons, limes, oranges, and grapefruit); (2) tomatoes (both fresh and canned); and (3) raw leafy green vegetables (spinach, cabbage, lettuce, etc.).

Vitamin D is necessary for the growth and health of *bones*, *teeth*, and *nerves*. No matter how much calcium and phosphorus are available in the blood, the cells cannot use them unless vitamin D is present also. As mentioned before, the disease *rickets* (page 56) may be caused by a lack of any one of these three essentials, though the vitamin is most apt to be missing.

None of the natural foods is rich in vitamin D. Cream, butter, and egg yolk contain some, but it would take 2 pounds of butter or 25 egg yolks to furnish the daily requirement of a small child. Hence we must rely on the following concentrated sources: (1) cod- and halibut-liver oils, (2) viosterol, (3) irradiated vitamin D milk, and (4) sunshine.

Vitamin D is called the "sunshine vitamin" because it is now known that the ultraviolet light in sunshine can manufacture this vitamin from a substance in the skin called *ergosterol*. For many years, without scientific reasons, sun bathing has been used as one of the best cures for rickets. Sun bathing for babies and children is now a routine procedure.

Unfortunately, ultraviolet rays are absorbed by ordinary window glass, clothing, fog, dust, and smoke. Both adults and children who live in foggy or smoky areas should take concentrated vitamin D, especially during the winter.

Vitamin E is especially important for the health of the reproductive cells. It is so widely distributed in foods, however, that there is little danger of a human being's suffering from the lack of it.

Vitamin G or B_2 has the specific function of promoting *growth in children* and *bodily vigor in adults* by its beneficial effects on the *digestive system* and the *nerves.* It is also called the *antipellagric* vitamin because its lack has been found to be the cause of *pellagra.* This disease is very prevalent in our own southern states, yet proper diet is all that is necessary to prevent it. Its chief symptoms are skin sores, swollen and sore mouth, red tongue, and impaired digestion. In later stages it results in convulsions, insanity, and sometimes death. It is now cured by vitamin G in pure crystalline form extracted from liver. (See Fig. 17.) The richest food source of vitamin G is yeast, with liver second. Green, leafy vegetables are excellent sources while milk, eggs, fresh lean meat, and root vegetables contain a good supply.

Vitamin K, recently discovered, is valuable for its blood-clotting ability. New-born infants are usually deficient in this vitamin, hence bleed easily. Vitamin K has already saved the lives of many such children. It is also given before operations, to prevent bleeding. Its chief source is leafy green vegetables.

Alkali- and acid-forming foods. Advertisers of various foods and patent medicines say much about "keeping alkaline." Ordinarily all the body fluids, except gastric juice, are neutral (neither acid nor alkaline) or are slightly alkaline, and they must maintain a certain degree of alkalinity in order that the cells may function normally.

Now, after foods are burned by the cells they leave in the blood a residue or ash which may give an acid, alkaline, or neutral reaction. This reaction is in no way related to the taste of the food. For instance, citrus fruits are acid to the taste, yet their residue has an alkaline effect on the blood. The following simplified classification includes most foods.

Alkalizing or base-forming foods: (1) Milk and milk products; (2) all fruits, except plums, and cranberries; (3) all vegetables except corn and cucumbers; and (4) all nuts except peanuts and walnuts.

18 Good sources of vitamin G are milk (all forms), cheese, eggs, lean-muscle meats, liver and other edible organs, green leaves, and the germ portion of cereals. (Courtesy of the United States Bureau of Home Economics)

Acid-forming foods: (1) Meat, fish, oysters, poultry, (2) eggs; and (3) all cereals, grain bread, pastries, and other products made from any kind of *grain.*

Neutral foods: Oils, fats, and sugar.

Although the alkalinity of the blood does not change rapidly, the habitual consumption of a large proportion of acid-forming foods probably has an effect. If the alkalinity of the body is very low, several weeks or longer on an alkaline diet may be necessary to restore it to normal. It is therefore safest to form the habit of eating more alkaline than acid foods. This need not complicate the planning of your diet, however, for if you eat enough fruits and vegetables to furnish the needed vitamins and minerals (page 66), you will automatically maintain the alkalinity of the blood.

The varying need for bulk. The indigestible fiber in plant foods furnishes *bulk,* gives the intestines "something to work on," and mechanically stimulates their action. The type of fiber-bearing foods which are needed varies greatly with the individual. As indicated in the footnote,[1] various foods contain harsh or soft fibers. Chronically constipated people may need some of the harsh-fibered foods, whereas persons with ulcers or colitis should refrain from taking these foods. Normal individuals need plenty of soft-fibered foods and a reasonable amount of harsher ones. The fiber intake should be regulated so as to insure at least one normal bowel movement each day.

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[1] *Soft-fibered foods:* (1) Raw-fruit pulp without skins or seeds; (2) cooked fruits; (3) some cooked vegetables that are young and tender or have been run through a sieve; and (4) finely ground whole-grain cereals *softened by long cooking.*

Harsh-fibered foods: (1) Raw fruits with skins and seeds; (2) raw vegetables such as carrots, celery, etc., (3) coarsely ground whole-grain cereals; and (4) some cooked vegetables such as leafy greens, peas, and corn.

Foods lacking fiber: Fats, milk products, peeled potatoes, white-flour bread, cakes, and pastries, meat, highly milled cereals such as cream of wheat, corn flakes, grape-nuts, and white or puffed rice.

Why you need water. You can go without food for weeks or even months, but you cannot live without water for more than a few days. If the blood and lymph lack sufficient water, the chemicals in them become so concentrated that they interfere with the work of the cells and ultimately result in death. A good supply of water helps the kidneys to take wastes out of the blood and the intestines to eliminate food wastes. An inadequate amount of water may cause headaches, nervousness, poor digestion, constipation, and other troubles. Ordinarily you need at least 6 to 8 glasses of water daily, with more in warm weather.

Conclusion. In order to supply your many types of cells with all the materials they need for building, repair, and the manufacture of substances, as well as for fuel, you need to eat a *wide variety* of foods. The United States Government nutrition experts have given us a "Master Diet Plan" which you should follow to assure getting all the food essentials you need. You will find this plan in "Your Health Habits," page 66.

ACTIVITIES

1. Self-check on your study of this problem. See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. A summary. Make a chart entitled, "Foods I Need Daily." Rule three wide vertical columns and head them (1) "Substances I need," (2) "Why I need each," and (3) "Common sources from which I can get each." Rule paper horizontally to make spaces about an inch or more deep. In the first column put (*a*) carbohydrates, (*b*) fats, (*c*) proteins, (*d*) iron, (*e*) calcium, (*f*) phosphorus, (*g*) iodine, (*h*) vitamin A, (*i*) vitamin B_1, (*j*) vitamin C, (*k*) vitamin D, (*l*) vitamin G (or B_2), and (*m*) bulky foods. Fill in spaces as indicated by their headings.

3. Key words. Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each:

nourishment
calorie
basal metabolism
carbohydrates
fats
proteins
minerals (in food)
vitamins
bulky foods
deficiency diseases

4. An exhibit. Make an exhibit of 100-calorie portions of common foods, grouping them according to the most prevalent nutrient other than water.

5. Your own calorie needs. Calculate the number of calories you need daily as follows: For one (or more) *normal* days, keep a record of what you do. Make a sheet like Table II, page 53, filling in column B with the average time you usually spend in each type of activity. Be sure it totals 24 hours before going ahead. Then multiply each item in column A by the hours opposite it in B, placing your answers in C. Add column C and multiply the result by your weight to get the number of calories you use daily.

6. Your daily diet. *Note:* This activity is well worth the time it takes. Make it a three- or four-day project, if necessary. Check the adequacy of your diet as follows:

a. Make a table using the headings shown in Table I, page 46, omitting the "weight," "excess acid," and "excess alkaline" columns. In the first two columns, keep an accurate record of *everything* you eat and drink for any normal 24-hour period. Record each item separately, *i.e.*, for "sandwich" record bread, butter, peanut butter, and the quantity of each. Estimate the number of calories for each. Record the plus signs as on the chart, doubling the number for double servings. Omit fractions (this method is inexact, of course, but it gives you a fairly good picture of your diet). Total the calories. Total the X's for each column.

b. Compare total calories you ate with total you need as found in Activity 5, above. Are they approximately equal? (Discount variations up to 200 calories as errors in judgment.) If they are very unequal, can you explain the reason?

c. The total X's for proteins, fats, and carbohydrates should be about equal. This does not mean that you ate equal amounts, but this table is so constructed that ordinary well-balanced diets give that result. Your proteins may show properly 5 to 10 X's *less* than the carbohydrates and your fats may be any amount *less* (if you are reducing), but *neither should be more than the carbohydrates.*

d. Did you have plenty of each vitamin and mineral listed? For each one, except iron, you should have at least 6 to 10 X's for each 1,000 calories of food eaten. For iron, about 4 to 7 X's per 1,000 calories. Check these also by seeing if you had the requirements listed in *Your Health Habits*, on page 66.

e. Did you eat at least three fibrous or bulky foods (or enough to secure one or two normal bowel movements)?

f. From your findings in **b** to **e**, do you find any serious errors in your diet? If so, state specifically what you intend to do to correct them. (Remember, these standards are for *normal*, *healthy* persons. If you are ill, ask your doctor what to eat. If you are trying to reduce or gain, check your diet according to rules given in Problem IV.)

Your Health Habits

Check yourself on the following habits. Each day do your foods include items from *each* group in this "Master Diet Plan"[1]?

a. *Milk* — ¾ to 1 quart every day for a growing child; 1 quart for expectant or nursing mothers; 1 pint for everyone else.
b. *Tomatoes, oranges, grapefruit, green cabbage, raw salad greens* — 1 or more servings daily for everyone.
c. *Leafy, green, or yellow vegetables* — 1 or more servings daily.
d. *Potatoes, other vegetables, and fruits* — 2 servings or more daily.
e. *Eggs* — 1 a day (or at least 3 or 4 a week).
f. *Lean meat, poultry, fish* — 1 or more servings a day.
g. *Cereals* — at least 2 servings of whole-grain products or "enriched" bread daily.
h. *Fats and sweets* — some butter or vitamin-A-rich fat every day, and enough more fats and sweets to satisfy the appetite.

SUGGESTED REFERENCES[2]

Acheson, M., "Sing a Song of Green and Yellow," *Hygeia*, September, 1939.

Barber, Edith M., *What Shall I Eat?* The Macmillan Company, New York, 1933.

Bogert, L. Jean, and Porter, M. T., *Dietetics Simplified*,* 2nd ed.; The Macmillan Company, New York, 1940.

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[1] U.S. Department of Agriculture, Bureau of Home Economics, Washington, D.C., 1941, Publication 2552–41.

[2] In addition, use books listed in *General References* in the Appendix. Use index of each book. Also use Reader's Guide in your library for splendid, up-to-date magazine articles.

* For advanced pupils and teachers.

Borsook, Henry, *Vitamins, What They Are and How They Can Benefit You,** The Viking Press, New York, 1941.

Clendening, Logan, *The Balanced Diet,* D. Appleton-Century Co., New York, 1937.

Fishbein, Morris, "The Truth About Candy," *Hygeia,* December, 1937.

Graves, L. G., "Food Fallacies," *Parent's Magazine,* November, 1937.

Holmes, Harry N., *Have You Had Your Vitamins?* Farrar & Rinehart, New York, 1938.

Parran, Thomas, *Vitamin Chart,* New York State Department of Health Nutrition Service.

Rose, Mary S., *The Foundations of Nutrition,** The Macmillan Company, New York, 1938.

Sansum, M. D., Hare, R. A., and Bowden, Ruth, *The Normal Diet and Healthful Living,* The Macmillan Company, New York, 1936.

Sansum, M. D., *The Normal Diet,* C. V. Mosby Co., St. Louis, 1930.

Short, James J., "The Alkalize Notion," *Hygeia,* March, 1939.

Sure, Barnett, *The Little Things in Life,* D. Appleton-Century Co., New York, 1937.

The Canned Food Handbook, American Can Company, 230 Park Ave., New York.

* For advanced pupils and teachers.

Problem 4. *How Should You Choose Your Food?*

> All human history attests
> That happiness for man, — the hungry sinner! —
> Since Eve ate apples, much depends on dinner.
>
> — BYRON, *Don Juan*

STUDY OUTLINE

A. How to plan your meals
  1. How can each individual tell how he should eat?
  2. Can you plan a well-balanced diet
    a. For yourself?
    b. For a family with varying needs?

B. Your weight and your choice of food
  1. How much should you weigh?
  2. Under what circumstances is overweight or underweight apt to be unhealthy?
  3. How can one gain weight?
  4. What is the safe way to reduce?

MANY football teams with national reputations are given three meals a day by their alma maters — just to make sure the players are fed scientifically. All coaches know that the performance of an athlete depends on the type of food he eats as well as on his direction of the energy derived from it.

To be able to select foods for maximum performance, you must have a knowledge of two things: (1) yourself, and (2) the simple principles of nutrition. Then you must actually apply that knowledge. If, however, you have any disease or weakness, you should allow no one but a qualified physician to prescribe your diet.

19 Preparation of meals outdoors as well as in a kitchen is fun as a hobby and remunerative as a craft. (Courtesy of Los Angeles Board of Education)

HOW TO PLAN MEALS

Many ills result from a long succession of haphazard meals or from the habit of eating whatever strikes the fancy or happens to be handy. Such carelessness is always paid for in decreased efficiency or more or less serious illness.

Scientific meal planning gives great satisfaction and is not complicated. It may appear complicated to the beginner when told that a complete and balanced diet [1] is essential to meet the needs [2] of the individual. He is still more confused on learning that it must contain carbohydrates, fats, and proteins in the right proportions, and must supply all the minerals and vitamins needed by the human body, and enough fiber to keep the digestive system clean and toned up. Yet a few simple rules combine all these requirements, and a little practice makes correct meal planning almost automatic.

What "good meals" are. Dietitians define good meals as those which (1) supply the body needs, (2) protect against disease, and (3) give enjoyment. With the principles given in this and the previous problem you can easily choose food to fulfill the first two requirements; yet how much you enjoy food depends greatly upon your taste for it and your attitude toward eating. Train yourself to enjoy all foods. Fortunate are those whose mothers trained them in early infancy to enjoy the foods their bodies need.

Your age and your food. The needs of different age groups vary. Children 6 to 12 years of age need a great deal of milk and cereal and smaller amounts of meats and sugars. High-school boys need relatively more cereals and bread, and girls need proportionately more salads and vegetables. Growing persons require a much larger percentage of milk, fruits, and vegetables for healthy growth than adults do for normal maintenance and repairs. Adults need relatively more meat and eggs and less milk. The proteins in meat and eggs are more digestible for them than those in milk.

If meals have been planned according to the suggestions which follow, all members of a family may satisfy their own particular requirements by eating varying proportions of the foods set before them. In this way all, young and old, underweight and overweight, may be properly fed at the same table.

How to plan well-balanced meals. You may use great freedom in adapting any menu pattern to your own needs. The important thing is to get, sometime during the day, all the foods you need in about the correct proportions. To do this, most people find it

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[1] *Daily diet* means all the food a person eats during the day. "Diet" may refer to food ordinarily eaten or selected with reference to a particular state of health.

[2] Remember that the needs of a person depend on his age, sex, body size (height and weight), type, temperament, work, climate, season, and state of health of his mind and body.

20 Meals that are too meager, meals poorly prepared, meals low in protective foods breed danger. (Courtesy of Farm Security Administration)

easier to balance each meal. Such meals are also more interesting and appetizing.

Dietitians recommend combining a light meal with two heavier ones. The following meal plans are merely suggestions. They are intended for normal adults, though they are so flexible that they can be adjusted to suit the requirements of all but very small children.

Meal Plans for Breakfast [1]

Light	*Medium*	*Heavy*
(1)	(2)	(3)
Fruit	Fruit	Fruit
Breadstuff or cereal	Cereal or eggs	Cereal
Beverage	Breadstuff	Eggs or other hot dishes
	Beverage	Breadstuff
		Beverage

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[1] From L. J. Bogert and M. T. Porter, *Dietetics Simplified*, The Macmillan Company, New York, 2d revised edition, 1940, pp. 124, 125, and 127.

Meal Plans for Luncheon or Supper [1]

Simple			*More Elaborate*
(1)	(2)	(3)	(4)
Soup	Hot dish	Hot dish	Appetizer and/or soup
Salad	Dessert	Salad	Hot dish with vegetables
Dessert	Hot beverage	Dessert	Salad and/or dessert

Meal Plans for Dinner [1]

Simple		*More Elaborate*
(1)	(2)	(3)
Soup Meat (or meat substitute) with potato and 1 non-starchy vegetable Dessert	Meat (or meat substitute) 2 vegetables Salad Dessert	Soup and/or appetizer Meat (or meat substitute) 2 or 3 vegetables Salad Dessert

Note: Bread, butter, and beverages may be added to these menus as desired.

The following menus suggest how such meal plans could be carried out for one day. This particular sample plan combines a light luncheon with a fairly heavy breakfast and dinner. Note how easily the number of calories may be varied merely by changing the quantities rather than by omitting some types of food entirely and thereby unbalancing the diet.

Sample Meal Plans for Normal Diets at Moderate Cost

General Meal Plans	*Sample Meal*	*Calories*
	BREAKFAST (Breakfast 3, page 71)	
Fruit or fruit juice	1 glass orange juice	90
Cereal or extra fruit	½ cup oatmeal	70
	thin cream	60
	sugar	30
Eggs or other hot dish	1 egg	75
Bread	2 slices of wholewheat toast	140
Butter	1 square butter	75
Beverage	1 glass whole milk	170
	Total	710

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[1] From L. J. Bogert and M. T. Porter, *Dietetics Simplified*, The Macmillan Company, New York, 2d revised edition, 1940, pp. 124, 125, and 127.

LUNCHEON OR SUPPER (Luncheon 1, page 72)

Soup	½ cup vegetable soup	50
Salad	1 slice pineapple	100
	3 tbsps. cottage cheese	60
	3 large lettuce leaves	10
	(no dressing here)	
Dessert	½ cup tapioca pudding	125
Bread	1 slice wholewheat bread	70
Butter	½ square butter	40
Beverage	1 cup whole milk	170
	Total	625

DINNER (Dinner 2, page 72)

Meat (or other protein food)	1 slice roast beef (medium fat)	350
1 starchy food	1 medium baked potato	100
1 vegetable (nonstarchy)	¾ cup string beans	45
	1 square butter on beans	75
Salad or fruit cup	3 large lettuce leaves	10
	1 small tomato	25
	with salad dressing	100
Dessert	½ cup prune pudding	225
Bread	2 rolls (graham)	140
Butter	1 square butter on rolls	75
Beverage	Cereal, coffee with cream and sugar	100
	Total	1245
	Daily total	2580

The three meals during the day should supplement each other. A person who eats his food in a restaurant and chooses it on the spur of the moment should be especially careful to avoid ordering similar foodstuffs in succession. The easiest way to plan home meals to suit all the needs of a family is to write down menus for a whole day or two. This saves time, energy, and money, and prevents the common error of serving too little or too much of a variety at one meal.

For school lunches it is desirable, if possible, to take hot soup in a thermos bottle, or obtain a hot dish at school. In place of salads the lunch may contain raw fruit and vegetables such as apples, grapes, raw carrots, lettuce, olives, nuts, and dried fruit.

How to arrange heavy and light meals. It is unfortunate that breakfast is so often slighted. People who stay in bed until the last possible minute, rush with dressing, and eat on the run do themselves a great injustice. You need a good breakfast more than any other meal because (1) preceding it you have had the

21 Meals that are ample, meals well prepared, meals rich in protective foods build strength. (Courtesy of Department of Agriculture)

longest period without food, (2) your fuel supply (blood sugar) is lowest in the morning, (3) your body, like any other engine, needs to lay in a supply of fuel before the day's work, not after it, and (4) if you are unhurried, your food is more easily digested in the morning than when you are tired in the evening. It will pay to make breakfast one of your heavier meals and to discipline yourself to get up early enough to eat it leisurely.

Whether the light meal should be at noon or at night depends on the ages and occupations of the various members of the family. Those who do light work or study in the afternoon avoid drowsiness by a light lunch; on the other hand, a light meal at night is more conducive to sound sleep, especially for small children and elderly people. Each family must decide what arrangement suits it best.

YOUR WEIGHT AND YOUR CHOICE OF FOOD

Years ago it was stylish to be pleasingly plump. Streamlining now influences human figures and clothes as well as airplanes and automobiles. Nowadays almost everyone wants to be slender. As the pendulum of fashion swings, a large portion of humanity earnestly tries to put on fat or take it off.

Biologically, your body was not designed to meet the changing whims of Hollywood. It is a little ridiculous for a person with a short, stocky build to try to appear sylphlike or for one who is naturally slender to try to reduce "in spots." In the first place, you cannot do any more about the general type of skeleton you inherited than can a greyhound or a bull dog; and in the second place, unnatural-looking bulges, particularly of the hips, the back of the neck, and the abdomen are usually caused by poor posture (see Problem XII) and not by an overweight condition. Instead of trying to reduce an unsightly bulge, make your muscles assume their responsibility for an attractive appearance.

How to determine "normal" weight. Table III will give you the average weight of boys or girls of your age and height. It should be recognized that so-called normal weights are merely average weights. They do not allow for individual differences due to body type, racial and family heredity, and other factors. Variations of at least 10 per cent either above or below the averages given are considered within normal. If a person varies 15 per cent or more, the cause should be investigated even if he is not conscious of any immediate ill effects.

From insurance-company statistics authorities conclude that most people have the best chance for freedom from disease and for long life if they keep their weight slightly above the average indicated for them up to 30 years of age, and slightly below it thereafter.

Why try to control your weight? Extremely thin children and young people have little reserve in cases of common illnesses; they easily become anemic and frequently fall prey to tuberculosis. If they reach middle age, however, this type usually lives on and on with little to bother them physically. On the other hand, extreme overweight puts an extra burden upon the heart, the blood vessels, and the kidneys. Excessive masses of fat crowd the internal organs, tend to cut down muscular activity, put extra weight on the arches of the feet, and destroy health, efficiency, and good looks. Statistics show that extremely overweight people are more

TABLE III

Weight-Height-Age Table for Boys of School Age [1]

Height, inches	*Average weight for height, pounds*	5 *years*	6 *years*	7 *years*	8 *years*	9 *years*	10 *years*	11 *years*	12 *years*	13 *years*	14 *years*	15 *years*	16 *years*	17 *years*	18 *years*	19 *years*	*Height, inches*
38	34	34	34*														38
39	35	35	35														39
40	36	36	36*														40
41	38	38	38	38*													41
42	39	39	39	39*	39*												42
43	41	41	41	41*	41*												43
44	44	44	44	44	44*												44
45	46	46	46	46	46*	46*											45
46	48	47*	48	48	48	48*											46
47	50	49*	50	50	50	50*	50*										47
48	53		52	53	53	53	50*										48
49	55		55	55	55	55	55	55*									49
50	58		57*	58	58	58	58	58*	58*								50
51	61			63	61	61	61	61	61*								51
52	64			64	64	64	64	64	64	64*							52
53	68			66*	67	67	67	67	68	68*							53
54	71				70	70	70	70	71	71	72*						54
55	74				72*	72	73	73	74	74	74*						55
56	78				75*	76	77	77	77	78	78	80*					56
57	82					79*	80	81	81	82	83	83*					57
58	85					83*	84	84	85	85	86	87					58
59	89						87	88	89	89	90	90	90				59

60	94						91*	92	92	93	94	95	96				60
61	99							95	96	97	99	100	103	106*			61
62	104							100*	101	102	103	104	107	111	116*		62
63	111							105*	106	107	108	110	113	118	123	127*	63
64	117								109	111	113	115	117	121	126	130*	64
65	123								114*	117	118	120	122	127	131	134	65
66	129									119	122	125	128	132	136	139	66
67	133									124*	128	130	134	136	139	142	67
68	139										134	134	137	141	143	147	68
69	144										137	139	143	146	149	152	69
70	147										143	144	145	148	151	155	70
71	152										148*	150	151	152	154	159	71
72	157											153	155	156	158	163	72
73	163											157*	160	162	164	167	73
74	169											160*	164	168	170	171	74

The figures represent weight in pounds; age at nearest birthday; height at nearest inch; weight at nearest pound.

Starred figures are estimated weights for children who are taller or shorter than usual for the age group. All unstarred figures represent actual averages.

Weight in ordinary clothing but without shoes, coats or sweaters.

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[1] Tables prepared by Bird T. Baldwin, Ph.D., Iowa Child Welfare Research Station, State University of Iowa, and Thos. D. Wood, M.D., Columbia University. Reprinted by courtesy of the American Child Health Association.

TABLE III (*continued*)

Weight-Height-Age Table for Girls of School Age[1]

Height, inches	*Average weight for height, pounds*	5 *years*	6 *years*	7 *years*	8 *years*	9 *years*	10 *years*	11 *years*	12 *years*	13 *years*	14 *years*	15 *years*	16 *years*	17 *years*	18 *years*	*Height, inches*
38	33	33	33													38
39	34	34	34													39
40	36	36	36	36*												40
41	37	37	37	37*												41
42	39	39	39	39*												42
43	41	41	41	41	41*											43
44	42	42	42	42	42*											44
45	45	45	45	45	45	45*										45
46	47	47*	47	47	48	48*										46
47	50	49*	50	50	50	50	50*									47
48	52		52	52	52	52	53*	53*								48
49	55		54	54	55	55	56	56*								49
50	58		56*	56	57	58	59	61	62*							50
51	61			59	60	61	61	63	65							51
52	64			63*	64	64	64	65	67							52
53	68			66*	67	67	68	68	69	71*						53
54	71				69	70	70	71	71	73*						54
55	75				72*	74	74	74	75	77	78*					55
56	79					76	78	78	79	81	83*					56
57	84					80*	82	82	82	84	88	92*				57
58	89						84	86	86	88	93	96*	101*			58
59	95						87	87	90	92	96	100	103*	104		59

60	101						91*	95	95	97	101	105	108	109	111*	60
61	108							99	100	101	105	108	112	113	116	61
62	114							104*	105	106	109	113	115	117	118	62
63	118								110	110	112	116	117	119	120	63
64	121								114*	115	117	119	120	122	123	64
65	125								118*	120	121	122	123	125	126	65
66	129									124	124	125	128	129	130	66
67	133									128*	130	131	133	133	135	67
68	138									131*	133	135	136	138	138	68
69	142										135*	137*	138*	140*	142*	69
70	144										136*	138*	140*	142*	144*	70
71	145										138*	140*	142*	144*	154*	71

The figures represent weight in pounds; age at nearest birthday; height at nearest inch; weight at nearest pound.

Starred figures are estimated weights for children who are taller or shorter than usual for the age group. All unstarred figures represent actual averages.

Weight in ordinary clothing but without shoes, coats or sweaters.

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[1] Tables prepared by Bird T. Baldwin, Ph.D., Iowa Child Welfare Research Station, State University of Iowa, and Thos. D. Wood, M.D., Columbia University. Reprinted by courtesy of the American Child Health Association.

susceptible to high blood pressure, hardening of the arteries, diabetes, kidney disease, and certain other disorders. People who come within the range of "normal" are the freest from physical ailments.

How to gain weight. For most people it is much more difficult to gain weight than to reduce. The usual history of persons trying to gain is first an upward spurt, then a sudden drop which sends them back nearly to the starting point, and then a long, slow climb, interrupted by numerous similar setbacks. The cause of a sudden decline is usually indigestion or a cold which results from taking in food faster than the body can assimilate it, thus clogging the system. A key principle for everyone, regardless of weight, is to *make changes in eating habits slowly and carefully* in order to give the body time to adjust itself to new amounts or kinds of foods.

If underweight is due mostly to an inadequate diet, insufficient sleep and relaxation, too much hard work, or negative mental attitudes, then an individual may expect to gain by using the *Suggestions for Gaining Weight*, which follow. If, however, it is caused by overactive glands, inefficient digestion or assimilation, infected tonsils or other diseased conditions, there is little chance of helping himself without the aid of a physician. All extremely underweight persons should be examined by a doctor.

Suggestions for Gaining Weight

1. *Calculate your calorie needs* on the basis of your weight (see page 53), and then add 500 to 1,000 calories.

2. ***Gradually** change eating habits* until you are able to take all of the required kinds and amounts of food recommended in the well-balanced diet plan on pages 72 and 73, *plus* the following:

Breakfast: 1 extra fruit, preferably stewed dry fruit, jam, or jelly.
Luncheon: 1 starchy vegetable
Dinner: 1 extra vegetable
Between-meal lunches:

mid-forenoon and mid-afternoon and bedtime	fresh fruit *or* dried fruit *or* milk *or* cocoa, ovaltine, malted milk *or* glass orange juice with 1 or 2 tablespoons of olive oil (very effective)

Eat freely of high-calorie foods marked with (*) on the Table of Food Values on pages 46–51. Use creamed dishes — soups, vegetables, and desserts. Increase the amount of cream, butter, and salad oil you ordinarily use.

3. *Take concentrated preparations of vitamins.* If you lack a good appetite and your digestive apparatus needs to be stimulated, take vitamins B and G ("B complex") in a form put up by reliable drug companies. In winter take cod- or halibut-liver oil to get abundant amounts of vitamins A and D also.

4. *Get extra rest.* Sleep 8 to 10 hours per night and relax for at least 10 minutes before and after meals, especially if tired. This assists the digestive system.

5. *Practice good health habits in general.* Stimulate breathing, circulation, and elimination by moderate exercise. Get out in the sunshine. Don't worry about yourself or things in general, and avoid other undesirable mental reactions.

6. *Be content to gain slowly.* One pound per week equals 52 pounds per year! Don't "stuff" yourself at first. At the first sign of a cold or indigestion eat lightly or go on a fruit-juice diet for a day or so. This will prevent setbacks and spasmodic periods of gaining and losing.

How to reduce. All extremely overweight individuals should be under the care of a physician. Too rapid reducing is a great strain on the whole body and endangers health. Many overweight cases are due to glandular maladjustment. The reducing diet for such persons should be prescribed especially by a physician. The following suggestions are safe for those who are confident that they are overweight because they eat too much.

Suggestions for Losing Weight

1. *Calculate your calorie needs* on the basis of your weight (see page 53), and then subtract 500–1,000 calories.

2. ***Gradually** change eating habits* until you are eating the required kinds and amounts of foods recommended in the well-balanced diet plan on pages 71–73, except for the following:

Breakfast: Omit cereal and sweetening for fruit or beverage.
Luncheon: Omit bread and butter.

Dinner: Omit bread and butter; substitute an extra non-starchy vegetable for the starchy one. Substitute fresh fruit for any high-calorie dessert.

At all times: Omit sodas, sundaes, nuts, sweetening in beverages, milk drinks, salad dressings except those made with mineral oil, fat fish or meat, pastries, and other rich foods. Eat sparingly of all high calorie foods marked with (*) on the food chart on pages 46–57. Select necessary calories from low-calorie foods such as fruits, vegetables, lean meat and fish, and thin soups (not creamed). *Important: Use adequate amounts of bulky foods.*

3. *Be sure to get vitamin and mineral requirements.* If in doubt about getting enough, take concentrated preparations of them.

4. *Never be hungry!* Keep a few of your favorite low-calorie foods on hand to eat whenever you feel hungry. This prevents indulging in fattening foods.

5. *Practice good health habits in general.* Regular elimination is most important. Exercise out of doors, but not so much that you stimulate your appetite and offset the calories burned.

6. *Be content to reduce slowly.* By burning 500 to 1,000 calories of your own body fat per day, you should lose a pound in 4 to 8 days. (Each pound of human fat equals 3,600–4,000 calories.)

7. *Practice self-control and moderation* in all things. The most difficult part of your reducing program may be to learn to say "no" to yourself. To help yourself forget food keep your mind occupied with other things.

How not to reduce. Common are the advertisements of patented beverages, breads, pills, salts, massage creams, and exercise machines for reducing. Most of these do no good whatsoever, while some of them are exceedingly dangerous. Those that threaten the health and even the life of their users contain: (1) *strong laxatives*, which flush the food through the body so fast it cannot be absorbed, and whose constant use causes anemia and deficiency diseases; (2) *gland extracts*, which are always dangerous except when prescribed by a physician; and (3) *powerful drugs.*

Conclusion. Although individuals vary greatly in their food needs as regards quantity, proportion of various nutrients, arrangement of light and heavy meals, and taste for specific foods, still they *all* require the same fundamental nutritive factors, especially minerals and vitamins. Hence a family of people of various ages with some overweight and some underweight may all eat the same meals if the foods are chosen to include all food essentials, are plainly but well cooked, and are not overly seasoned. From such foods each individual may choose the proportions best suited to his own needs.

ACTIVITIES

1. Self-check on your study of this problem. See now if you can answer all the questions in the study outline for this problem. Discuss them in class.

2. School-cafeteria project. In consultation with your cafeteria officials, post daily a list of foods that would comprise a balanced lunch. Suggest a plate luncheon at about 15 cents.

3. Planning your own diet. Plan a well-balanced diet that fits your mode of living, your activity, and your special needs. Let this be a proper conclusion to the Activity on "Your Daily Diet," page 65. See that it meets the requirements in *Your Health Habits*, page 66.

4. An exhibit. Make an exhibit of well-balanced meals for one day for (**a**) an average high-school boy, and (**b**) an average high-school girl.

5. Oral and written reports:

a. Diet and its effect on adolescent complexion.
b. Diet for athletes in training.
c. Diet to help prevent and cure a cold.
d. Diet for expectant and nursing mothers.
e. Diets for growing children.
f. Infant feeding, formulas, and care of bottles.
g. Feeding dogs and cats properly.
h. The Pure Food and Drug Act (1938 revision) and the need for consumer education. Does the public need protection? To what extent are you protected against false advertising? What can the public do further to protect itself against unscrupulous manufacturers?

6. A book report. Report on some book dealing with consumer education, such as "Consumer's Guide" and other United States government publications, "Consumer's Research," and "Consumer's Union."

7. Writing for pamphlets. Write to Superintendent of Documents, Washington, D.C., for a check list of *Government Publications for the Use of Consumers*. From this list, write again for pamphlets most valuable to you and your classmates. Report on what you learn from them as to how to buy foods.

8. Key words. Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each:

balanced diet
meal plan
normal weight

Your Health Habits

Check yourself on the following habits. Do you —

a. Eat a balanced diet?
b. Eat one light and two heavier meals daily?
c. Select your food according to your weight?
d. Avoid patent medicines for gaining or reducing?

SUGGESTED REFERENCES [1]

Diehl, Harold S., *Healthful Living*, McGraw-Hill Book Co., New York, 1940. Chap. V.

Geraghty, E. M., "Reducing Diet," *Hygeia*, January, 1939.

Hambridge, Gove, *Your Meals and Your Money*, Whittlesey House, New York, 1934.

Hardgrove, Maurice, "How to Reduce," *Hygeia*, April, 1937.

Eddy, W. H., "Avoid pitfalls in the reducing game," *Good Housekeeping*, October, 1938, p. 160.

—— *Overweight and Underweight*, Metropolitan Life Insurance Co., New York. (Write for this pamphlet.)

Stiebeling, "Can your menus pass this test?" *Woman's Home Companion*, October, 1939.

Rose, Mary S., *Feeding the Family*,* The Macmillan Company, New York, 4th ed., 1940.

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[1] See also, Barber, Sansum, Bogert and Porter, and Rose — references in Problem 3, pages 66 and 67.

* For advanced pupils and teachers.

Problem 5. *What Happens to Food in the Body?*

> I am convinced, digestion is the great secret of life.
>
> — SYDNEY SMITH

STUDY OUTLINE

A. The meaning of digestion
   1. How does the body make use of its food supply?
   2. Why must foods be changed (digested) before the body can use them?

B. How the digestive system operates
   1. What are the scientific reasons for chewing food?
   2. How is food moved through the alimentary canal?
   3. How does each organ do its part in digestion?
   4. How does digested food get into the blood stream?
   5. What is the purpose of the large intestine?

C. How to keep the digestive system in good working order
   1. Why should meals be eaten only when one is in a pleasant mood?
   2. Why should you not swim or play hard soon after eating?
   3. Why should you not eat when tired?
   4. What foods are most easily digested?
   5. How should foodstuffs be cooked to be most digestible and nutritious?
   6. Should one drink water with meals?
   7. How can constipation be avoided?
   8. In what ways are various food fads unscientific?

SINCE you eat to feed tissue cells and not the stomach, your digestive system is simply a machine for changing food into a form that your cells can use. Food actually does not become a part of the body until after it has been absorbed from the digestive organs by the blood stream. As long as it remains in the digestive tract, it is merely in a hollow tube running through the body, with walls continuous with the skin.

This tube — the *alimentary canal* (see Problem 2, page 33) — consists of a series of chambers in which food is ground and refined. It may be compared to a factory where raw material is taken in at one door and passed from room to room, undergoing successive processes until at last the finished product is ready for the consumer and the refuse is prepared for disposal.

THE MEANING OF DIGESTION

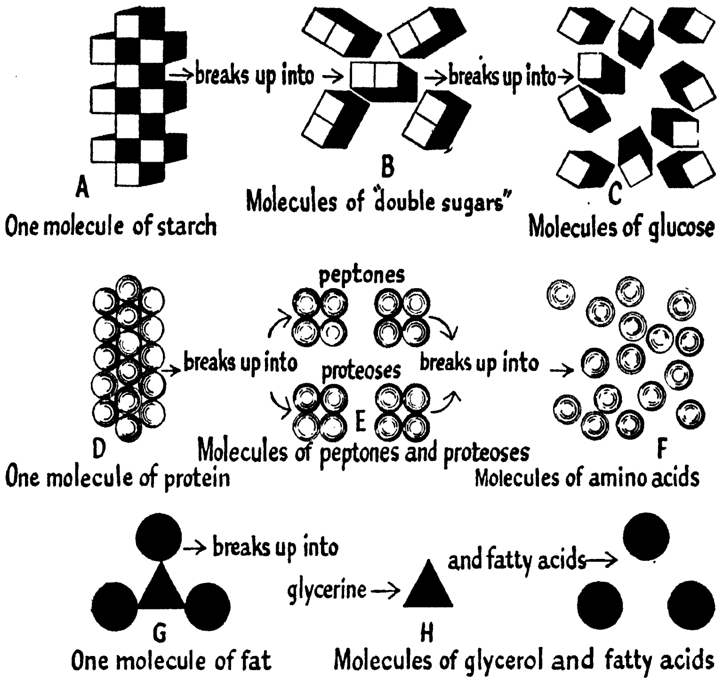
Food cannot be absorbed by the blood nor can it be used by the body cells until it has been broken up into tiny particles. It must then pass through the lining of the small intestine into the blood stream and from there into the cells by osmosis. The process of breaking food down into usable forms is called *digestion.* (Study Fig. 22 carefully for a general idea of the splitting process.) The molecules of some foods are so small and soluble that they require little or no change. Others are so large that they have to be split and re-split several times before they can be absorbed. (Review page 33).

Carbohydrate digestion — a varied process. All carbohydrates from potatoes, corn, sugar, or any other source — are composed of the same simple substance known as *glucose.* Glucose molecules are extremely small and single (not grouped) so that they dissolve instantly in water and pass through membranes by osmosis. When any carbohydrate food is to be digested, it must be broken down into these tiny molecules of glucose. (See Fig. 22A, B, C.)

Carbohydrates do not all digest with the same ease. The natural sugar found in honey and in fruit and vegetable juices is quickly assimilated. It is in the simplest form (glucose or "single sugar") and needs no digestion. Within half an hour after drinking a glass of orange or grape juice its sugar has reached the body cells and is ready for use.

Ordinary cane and beet sugars are more complicated. They are called "double sugars" because they are composed of pairs of glucose molecules. These molecules must be torn apart in the digestive process.

Starches are formed by the union of many glucose molecules and hence are called "many sugars." Some starch molecules are



22 The real meaning of digestion. Molecules of food, acted upon by digestive enzymes, break down into the smaller molecules of which they are built.

extremely large and complex. They must be split several times, hence they are among the most difficult of all foods to digest (see Fig. 22A). Heat can split these molecules once and change them to a simpler form called *dextrin*. When starchy foods have been heated sufficiently to cause this change, they are said to be "dextrinized." Dextrins are more quickly digested than starches but not so quickly as sugars.

Fat digestion — a one-step process. Fats are formed by the union of different *fatty acids* with a substance called *glycerol* (glĭs′-ĕr-ōl). When fats are digested (Fig. 22G, H) they are broken down into the fatty acids of which they are composed (usually several) and into glycerol. In this form they will pass through the intestinal walls.

Protein digestion — a many-step process. As explained in Problem 3, proteins are complex substances formed by the union of simple nitrogen-containing organic compounds called *amino acids*, of which there are at least 22. Digestion breaks down the protein molecule into the several amino acids from which it was originally built, as shown in Fig. 22D, E, and F.

Minerals, vitamins, and water are merely absorbed. These substances require no digestion. Water is absorbed into the blood without change; vitamins and minerals are merely dissolved and absorbed.

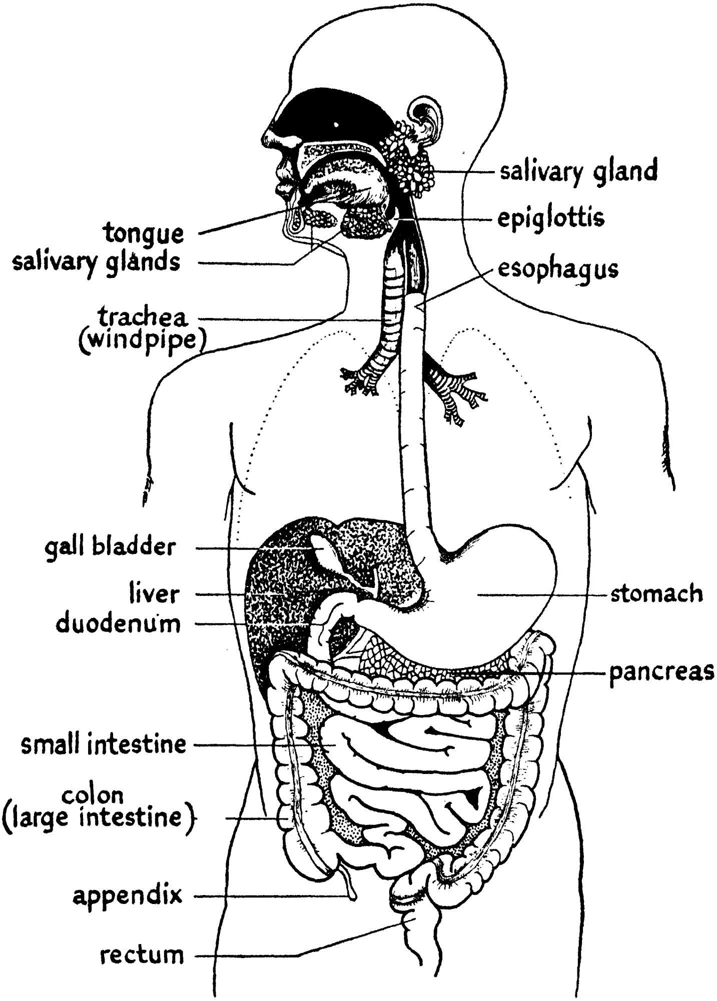
HOW THE DIGESTIVE SYSTEM OPERATES

The most remarkable canal in the world, the *alimentary canal,* is only about 30 feet long, with most of it packed into a mere cubic foot of space. It consists of several compartments, the *mouth, esophagus* (ē-sŏf′*ȧ*-g*ŭ*s), stomach, small intestine, and large intestine. All compartments, except the esophagus, perform definite operations in splitting up food molecules. The work of each consists of a combined *chemical* and *mechanical action.* The first is accomplished by digestive juices secreted by glands. The second is brought about by muscular contraction which churns and breaks up the food into small pieces so the digestive juices can reach all particles.

The chemicals used in digestion. The digestive chemicals are *enzymes* (ĕn′zīms). Although one digestive juice, such as saliva, may contain several of them, each enzyme acts only on certain forms of foodstuffs. If an enzyme is thoroughly mixed with food and given sufficient time to act, a small amount of it can change a large quantity of food. The enzyme itself remains unchanged.

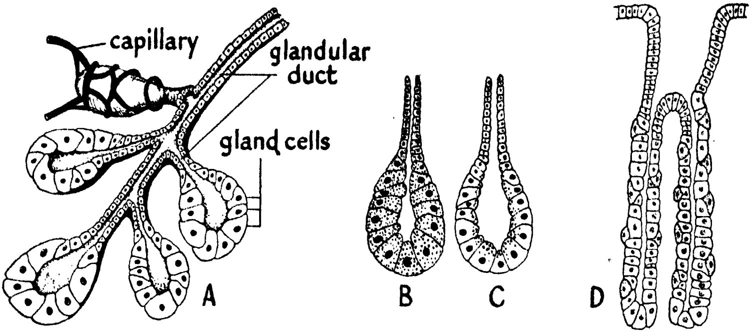
How the chemicals are produced. The digestive juices are poured into each food chamber from glands. Follow Fig. 23 to help you remember that: (1) the mouth receives *saliva* from six *salivary glands;* (2) the stomach receives *gastric juice* from thousands of tiny *gastric* (or stomach) *glands* in its lining; and (3) the small intestine receives *pancreatic* (păn′krē-ăt′ĭk) *juice* through a single duct from the *pancreas* (păn′krē-ăs), *bile* from the *liver* through the same duct, and *intestinal juice* from millions of tiny glands in its own lining.

Since all the glands furnishing these juices operate on the same principle, let us observe a salivary gland as an example. Its cells



23 The digestive system. Note that it is a continuous tube with accessory organs (glands) that pour digestive juices into it.

are arranged in one or more layers around hollow tubes or *ducts*, as shown in Fig. 24. When the cells manufacture saliva, they pour it into the nearest duct, from which it flows into a larger one that empties into the mouth. You can locate the openings of two of these ducts as slight depressions in the cheeks opposite your upper molar teeth.



24 Diagram showing structure of salivary and gastric glands. *A*. General structure. *B*. Cells of a rested gland with granules stored in them. *C*. Cells depleted by activity. *D*. Gastric gland.

When a gland is "at rest," its cells take in certain materials by osmosis from the capillaries and lymph around it(page 32). It stores its product in an unfinished concentrated form, ready for instant completion when the juice is needed. Glands need some resting time between meals to store these substances. Each gland produces its own particular chemical secretion.

Mixing vat 1 — the mouth. The mouth is a remarkable mixing vat. It contains normally a set of sharp grinding tools, the *teeth*, and a large flat muscle, the *tongue*. The tongue and cheek muscles keep the food between the teeth during the chewing process.

Opening into the mouth, as you have seen, are ducts from the *salivary glands* (Fig. 23). These glands secrete or give off daily about 1 to 2 quarts of saliva, a thin, colorless, slightly sticky, digestive fluid which contains two enzymes. Saliva moistens and softens all food, but it acts chemically only on starches. It splits their molecules and starts the process of changing them into simple sugars. To permit saliva to accomplish as much digestion as possible, the food must be chewed thoroughly before it leaves the mouth.

How food is swallowed. To understand how food reaches the stomach, study Figs. 23 and 53. Note that the roof of the mouth, with its bony *hard palate* and fleshy *soft palate*, is so shaped that when the tongue is pushed up against it, food is forced back and down into the throat or *pharynx* (făr′ĭngks). Muscles in the side of the throat near the base of the tongue grasp and push the food onward into the esophagus.

At the moment food is being swallowed, all of the other openings in the pharynx are closed except the one leading into the esophagus. The tip of the soft palate is raised against the back wall of the pharynx, thus closing the openings into the nose and ears. To laugh or cough suddenly while swallowing will cause the soft palate to relax and allow food to go up into the nasal passage.

Food is kept out of the windpipe (*trachea*) by an ingenious little trap door called the *epiglottis*.[1] Note on Fig. 53 that food would help the muscle action to force this downward. At the same time, the *larynx*, at the top of the windpipe, is lifted up under the epiglottis, as you may feel by placing your fingers lightly upon the "Adam's apple" when you swallow. Thus the air passage is closed tightly.

If, however, air from the windpipe forces the trap door open at the wrong time, some food may "go down the wrong way." This will cause choking and coughing until the food is forced back up the windpipe into the throat. Swallowing requires the intricate coöperation of many muscles, but the entire act requires less than a second of time.

Food is moved through the canal by peristalsis. Most of us are willing to let the law of gravity explain why swallowed food goes down the esophagus to the stomach until we learn that food will go *up* the esophagus to the stomach if we eat while we are turned upside down. Food is moved along by two layers of muscles which surround the esophagus. (See Activity 5.)

As soon as you swallow, a ring of muscle contracts just behind a morsel of food and starts a wormlike wave motion along the esophagus. The contractions of successive muscular rings push the food along. This action is known as *peristalsis* (pĕr′ĭ-stăl′sĭs). It occurs throughout the length of the alimentary canal and in most of the other tubes in the body which transport solids or liquids. It seems to be produced automatically when the contents press on the sides of these tubes. Vomiting is merely peristalsis in the reverse direction, starting at the stomach end of the esophagus and working toward the mouth.

Mixing vat 2 — the stomach. The stomach is a pear-shaped col-

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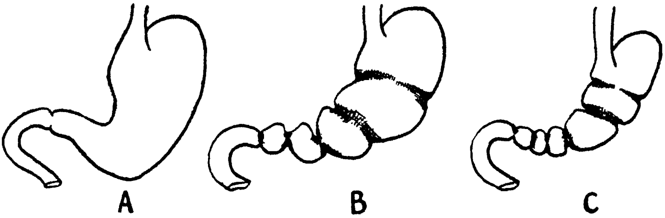
[1] At the top of the windpipe is the voice box with a slitlike opening called the *glottis*. "Epiglottis" means, literally, "over the opening."



25 The stomach in action — showing peristaltic action in pyloric portion and gradual decrease in quantity of food. *A*. Stomach full, *B*. Two hours later, *C*. Four hours after the meal.

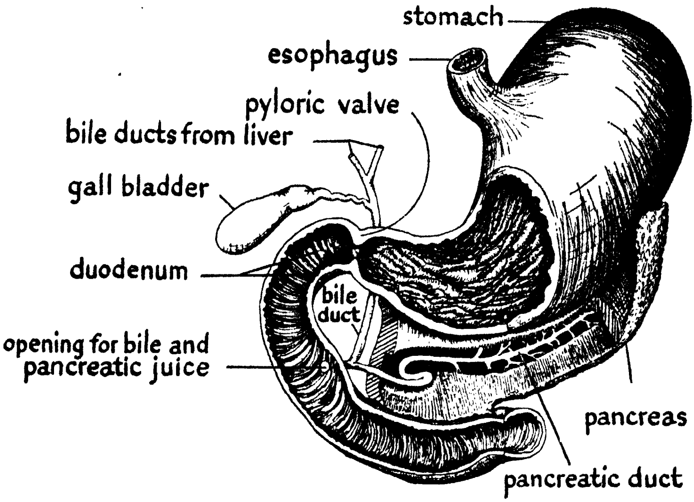
lapsible pouch which can hold about two quarts. When full, it is about 1 foot long and 5 inches in diameter. It lies mostly to the left of the center line of the body with the large end well up under the ribs. This upper portion of the stomach acts as a storehouse where food is retained until it can be churned and mixed with digestive juices in the outer portions of the stomach, as shown in Fig. 25.

As soon as food enters the stomach, peristaltic waves move slowly from the large to the small end leading into the small intestine. There each wave is reflected back by a ring of muscle which guards the opening (the *pylorus*, pĭ-lō′rŭs) between the stomach and the small intestine. This increases the *churning* activity within the stomach, which mixes the food thoroughly with the gastric juice.

The acid of gastric juice counteracts and stops the action of saliva. The central portions of food in the upper end of the stomach, however, remain untouched by gastric juice for some time, thus giving the saliva a chance to continue its action. This further signifies the importance of the thorough mixing of saliva with food.

Digestion in the stomach gradually reduces the food in the lower end of the stomach to a semifluid mass about the consistency of pea soup mixed with more or less solid particles. This is called *chyme* (kīm). Apparently, when some of the chyme becomes acid enough, the pyloric valve opens and permits a small quantity of it to enter the small intestine, ready for the next step in digestion. About two and one-half to five hours are required for all of a meal to pass through the stomach.

The finishing chamber — the small intestine. Contrary to popular belief, the greater part of digestion is carried on in the small intestine. The work of the mouth and stomach just start the



26 The stomach and duodenum, at rest. What is the purpose of the pyloric valve at the lower end of the stomach?

digestive process. The small intestine adds to the chyme three types of digestive juices containing many enzymes, and subjects it to vigorous peristaltic action. Seven hours or more are needed for a meal to pass through this section of the canal.

The small intestine is a long hollow tube approximately 1 inch in diameter and 20 feet long, coiled in the middle part of the abdomen. It is held in place by a transparent membrane of connective tissue called the *mesentery* which is attached to the abdominal wall near the spinal column. This thin membrane alone is not strong enough to support the weight of the intestines, which press forward and downward against the abdominal wall. It is therefore essential that the abdominal muscles be kept in good tone by vigorous exercise and that the abdominal wall be held in proper position by conscious effort until good posture becomes habitual.

The chemical action in the small intestine. The small intestine contains a seething mass of chyme and enzymes from the stomach, to which are now added bile, pancreatic juice, and intestinal juice, with their many enzymes (see Fig. 26). The presence of chyme in the duodenum stimulates the production of these juices.[1]

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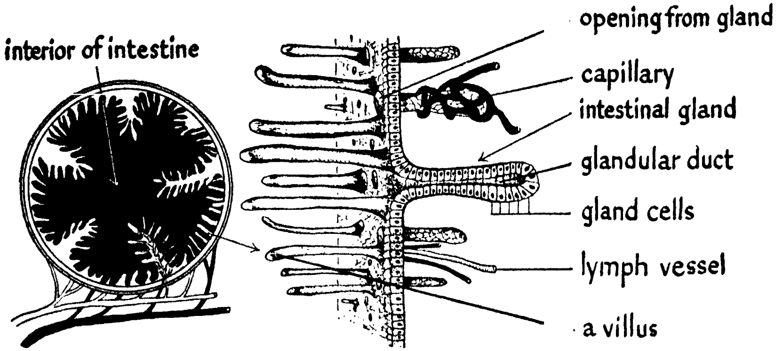
[1] If you are "chemically minded" and wish to study the detailed action of the various digestive enzymes, look up the laboratory manuals listed among the *General References* in the Appendix.



27 Glands and villi in the walls of the small intestine. Note the side of the drawing that would be the *inside* of the intestine. In which direction would the digestive juice be flowing? In which direction would the digested food be absorbed?

How digested foods get into the blood. There is evidence that the stomach walls absorb a little food, such as water, mineral salts, sugars, dextrins, and some drugs and alcohol. The small intestine, however, is the organ especially designed for absorption. It has thousands of tiny fingerlike projections called *villi* (vĭl′ī) which arise from its mucous-membrane lining and absorb the completely digested food (Figs. 27, 28). Each villus is covered with epithelial cells which have the peculiar power to absorb certain kinds of substances and to reject others[1]; that is, they allow only those particles to enter that have been properly digested.

In the center of each villus is a network of blood capillaries into which the cells pass all the absorbed materials except fat. The blood carries these substances to the liver for further chemical changes or for storage. The liver later distributes them through the general circulation as needed.

In the center of each villus is also a small lymph vessel, or *lacteal* (Fig. 28), which absorbs the digested fats. These materials are then carried through the lymphatic circulation and later emptied into the blood stream. By these means all of the end products of digestion finally reach the body cells.

The refuse storage tank — the colon. The *large intestine*, commonly called the *colon*, is about 2 inches in diameter but only 5 to

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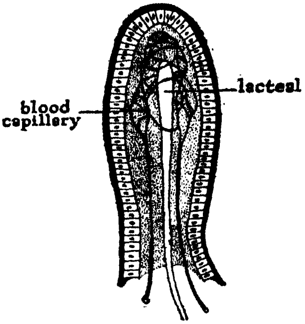
[1] A most graphic description of this is given in Henshaw Ward's *Exploring the Universe*, Bobbs-Merrill, Indianapolis, 1927, pp. 125–132. Choose a good reader from the class to read it aloud. Discuss it as he reads.

6 feet long. Starting at a point just in front of the right hip bone (Fig. 23), it ascends on the right side of the abdomen, crosses over below the liver and stomach, and descends on the left side to a point opposite its beginning. Here it makes a curve toward the center of the abdomen, and descends in a section called the *rectum*, to the outside opening, the *anus* (ā'nŭs). This is guarded by a circular muscle which keeps the tract closed except during defecation.



28 Enlarged diagram of one villus such as is shown in Fig. 27. What is the purpose of the capillaries and the lacteal within it? See text. (From Ella Thea Smith's *Exploring Biology*, Harcourt, Brace and Company)

Material entering the colon is in a watery state. It consists chiefly of indigestible residue and particles of food which have escaped complete digestion. Mixed with these are digestive juices, dead cells thrown off by the intestinal wall, enormous numbers of bacteria, living and dead, and mucus.

The chief work of the colon is to absorb water from the waste materials, thus reducing drastically their bulk, and to prepare the residue for elimination in comparatively solid form. The walls of the colon have a plentiful supply of mucous glands which add mucus to lubricate the mass and to prevent friction as it moves along. This waste material should be eliminated regularly, preferably at least once a day. The cause, effects, and remedy for faulty elimination are discussed on page 100.

The appendix — a potential trouble maker. As shown in Fig. 23, the appendix is located near the beginning of the colon. Its position is approximately midway between the upper edge of the right hip bone and the navel. It is a saclike projection, varying in size from 2 to 6 inches. It is believed to have been useful at some time in the history of man, but now appears to have no particular function. It may develop infection and inflammation, known as *appendicitis*. This disease is so common and so dangerous that you should be familiar with its symptoms and care. Acute appendicitis is characterized usually by (1) persistent pain in the abdomen (not necessarily over the appendix); (2) nausea; and

(3) fever.[1] If there is any abdominal pain persisting over 24 hours, call a doctor.

Important: If there is any suspicion of appendicitis, *never* give the patient a laxative nor use an enema, massage, or a hot-water bottle. Any of these may rupture a diseased appendix. The *only* thing you are safe in doing is to apply an icepack to the abdomen and call the doctor.

HOW TO KEEP THE DIGESTIVE SYSTEM IN GOOD WORKING ORDER

Three principal methods have been used for the scientific study of the digestive process. The *first* of these was discovered by accident. In 1822, St. Martin, a fur trapper who lived in northern Wisconsin, shot himself in the abdomen while he was cleaning a shotgun. An army surgeon named William Beaumont cared for him; but there were no anesthetics in those days, and St. Martin would not let the surgeon sew up the hole. After many months the wound healed, but an opening remained in his side. Dr. Beaumont quickly recognized this as an opportunity to study digestion.

Under varying conditions he checked the stomach temperature and collected gastric juice through the opening. His studies gave the world much accurate information concerning the production and action of gastric juice. His work pointed the way for the Russian physiologist, Pavlov, who made artificial openings into the alimentary canals of healthy dogs. By this means he was able to study the digestive process and the action of the digestive juices.

A second method of study arose with the development of the X ray and the fluoroscope. These instruments make it possible to observe movements of the digestive organs and the progress of food through the canal.

A third method is to study the contents of the stomach and the intestines. Food in various stages of digestion is removed by means of a stomach pump and is analyzed by a laboratory technician.

The last two methods are commonly used in diagnosing digestive troubles. Knowledge resulting from all these methods receives practical application in the following guides for good digestion.

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[1] It is to be noted that fever usually occurs as a result of infection and inflammation of the appendix. Thus, the body temperature may be normal during the earliest stages of appendicitis.

Make mealtime a happy time. The efficiency of digestion depends partly upon the state of mind. When you are hungry and look forward with anticipation to a meal, the digestive glands begin to prepare for it by secreting saliva and gastric juice. This, the "psychic factor" in gland stimulation, is exceedingly important in promoting good digestion. On the other hand, lack of appetite, caused by fear, anger, worry, or depressed spirits, decreases glandular secretion and peristalsis. The X ray shows that a cat's stomach will cease activity the instant an unfriendly dog is brought into the room. This digestive inactivity may last as long as an hour after the dog is removed.

From this and similar evidence we can conclude that *it is better not to eat when emotionally upset.* The setting for a meal should be as attractive as possible, and every participant should endeavor to make the meal a pleasant occasion. The table is not the place to discuss family troubles or unpleasant subjects.

Exercise. Vigorous exercise stimulates breathing and circulation and promotes appetite. People who are inactive and suffer from indigestion would be benefited by some form of physical activity. It is not advisable, however, to exercise vigorously immediately after eating (Fig. 29), because the muscles will require the extra supply of blood that should be available for the glands and the digestive organs.

If tired, rest before eating. Muscular fatigue is caused by a substance called *lactic acid,* which is produced by the muscle cells while working. When this lactic acid is distributed throughout the body by the blood stream, it apparently slows down the activity of other cells, including those of the digestive organs. Therefore, if you are physically exhausted at mealtime, it will aid digestion if you relax completely for 20 or 30 minutes before eating.

Eat foods in their most digestible and wholesome form. *Sugars* give "quick energy," especially those formed in honey and ripe fruits — fresh, dried, stewed, or canned. This makes fruits particularly good for between-meal snacks. The carbohydrates in *un*ripe fruits, however, are particularly *in*digestible. Cane sugar is not so easily digested as fruit sugars. Studies of the action of

29 How do you spend your lunch hour? *Above.* These pupils are benefiting by the relaxation, sunshine, and fresh air. *Below.* Why is such strenuous exercise likely to interfere with the digestion of the lunch these boys have just eaten?

candy show that it reduces the secretion of gastric juice and delays the emptying of the stomach. Hence candy should be eaten after meals, never before. Hard candies are preferable.

Starches should always be thoroughly cooked (by baking if possible) because some of the digestive juices do not act on raw starch at all and others only after several hours.

Protein foods are easily digested when boiled, broiled, or baked in a slow or moderate oven. Cooking at high temperatures, however, makes them tough and leathery. Then how should you cook eggs?

Fats in small quantities are needed by most people, yet for maximum health and good complexion fats should be eaten sparingly in summer and only moderately in winter. Remember, only one enzyme attacks fat, and that one is found only in the small intestine. Hence fat combined with other foods as in pastries and fried foods delays the digestion of the other foods by coating their particles so that enzymes cannot reach them until the coating is dissolved in the small intestine. This, of course, is too late for the proper digestion of most starches and proteins.

Cream and butter are the most digestible forms of fat. Acid with fat aids its assimilation. For instance, olive oil with orange juice is useful for thin-type people who otherwise cannot tolerate fat.

Vitamin foods should be cooked very little, and served raw when possible. Vitamins A and D are uninjured by cooking, but others are partially or wholly destroyed by high temperatures or dissolved in the cooking water. Therefore, cook your vegetables and fruits in covered dishes, with very little water, at low temperatures, and for as short a time as possible. Avoid copper kettles and the use of soda. Steaming or baking helps conserve vitamins. Drink the cooking liquid or use it in soups. Commercially canned fruits and vegetables are prepared scientifically and retain most of their vitamins. Tests show they contain more vitamins than most fresh vegetables cooked at home.

Drink water and fruit juices for health. Water contains no enzymes and should never be used in place of saliva as a moistener of food. It is a good rule *never to drink when there is any food in the mouth.* If water is used properly two or three glasses may be drunk with a meal without interfering with digestion. Generally speaking, ice water is undesirable unless sipped very slowly.

Start the day right with a large glass or two of cold or warm water. This cleanses the whole intestinal tract just as brushing the teeth washes away the filmy waste that collects during the night. The cleansing effect of water may be increased by adding some lemon or grapefruit juice. Or make the drink pure orange or grapefruit juice. This gives you extra vitamins and nearly 100 calories of easily assimilated sugar just when your blood sugar (fuel) is lowest.

For the rest of the day, arrange your own schedule for drinking water to get at least six glasses. When perspiring freely, drink much more water and add a little table salt to it to help replenish the body salts.

Chew all foods well. It is important to train yourself consciously to chew all foods well. Chewing not only grinds food finer but mixes it thoroughly with saliva. Plenty of saliva is necessary to stimulate the flow of gastric juice, which in turn is needed to induce a proper flow of intestinal juices. Thus thorough chewing not only grinds food but insures more successful digestion throughout the entire alimentary tract. It also assists in maintaining teeth and gums in healthy condition. (For care of teeth, see pages 211ff.)

Good teeth, of course, are essential to proper mastication and hence to good digestion. When teeth or gums are sensitive or tender from decay or disease, one is tempted to swallow food as quickly as possible to avoid the discomfort caused by chewing. A long train of serious disorders often follows.

Avoid foods that do not agree with you. For some reason not yet satisfactorily explained, many people are sensitive (allergic) to certain foods which others may eat and assimilate without any difficulty. These people should avoid the specific foods their systems cannot tolerate. (For *Allergies*, see page 424.)

Prevent constipation by correct habits. Many people have an unnecessary fear of constipation. This has resulted in vast fortunes in the pockets of laxative manufacturers and untold ills in the bodies of consumers. The truth is that many people who *think* they have constipation merely imagine it. They take one laxative after another, thus establishing a vicious habit and never realizing that they have no genuine constipation.

Even if one really has a sluggish colon the cure does not lie in repeatedly taking laxatives or enemas, although these measures may be necessary occasionally. The continued use of laxatives, bran, or enemas irritates and weakens the colon, sometimes resulting in a serious inflammatory condition called *colitis.* In addition it prevents proper digestion of needed foods.

The real cure (and prevention) of constipation lies in (1) a good normal diet with an extra quantity of fruit and bulky foods if necessary; (2) regularity of habits — a definite period and sufficient time each day for the colon to act naturally; (3) vigorous exercise involving the abdominal muscles; (4) generous amounts of drinking water, especially upon arising; and (5) sufficient rest and relaxation. Persistent cases should have the advice of a physician.

Beware of food fads. Anyone who has mastered the principles of digestion and nutrition set down in this unit can see for himself the fallacy in most food fads, many of which are based on superstition. Only a few need be mentioned.

Vegetarianism is unwarranted physiologically. Although man *can* live on plant proteins alone, a strict vegetarian must plan his meals with exceptional care in order to supply his body with adequate quantities of all the necessary amino acids. Most plant proteins are incomplete. Unless animal products, such as milk, cheese, and eggs are included in the diet, the vegetarian is almost certain to lack adequate nourishment.

The *raw-food fad* is based partly on the fact that it is important for everyone to eat some raw foods every day to be sure of getting an adequate vitamin supply. This, however, does not necessitate eating all foods in the raw state, moreover, there is danger in eating certain uncooked foods which have been chemically sprayed to protect them from insects, or which have been grown in soil contaminated by sewage. All uncooked foods, if their nature will permit, should be thoroughly washed and scrubbed with a vegetable brush under running water.

The *anticombinationists* insist that only one type of food should be eaten at a time; that "meat and potatoes together are indigestible"; that "milk must not be taken with fruit"; and even that "bread and milk is a bad combination." Such statements have no scientific evidence to support them.

Milk and certain acids are even more easily digested in combination than separately, for the acid breaks up the milk curds. Milk mixed with orange or lemon juice is given to children and to patients suffering from internal ulcers. You need fear none of these food combinations, except perhaps the simultaneous eating of acids and starches. Even this exception is not definitely established, but since the enzymes in saliva are inactive in an acid medium, it seems reasonable to suppose that the eating of an orange with a sandwich may delay the digestion of the bread.

Other *dieting fads* such as the no-breakfast plan, milk and bananas for reducing, the Hollywood diet, and other equally unscientific practices should need no special discussion. The reader is warned to keep in mind that the body *must* have all the food essentials discussed in Problem 3. Any system of eating which oversupplies some of them and eliminates others for longer than 3 to 14 days is likely to develop serious ills in the body. To be on the safe side, normal people should stick to a well-balanced diet, and those who are ill should have a physician prescribe their foods.

Conclusion. Digestion is a long process requiring several steps. The efficiency of each step depends upon how well the preceding ones were accomplished. Since the first step takes place in the mouth, it is very important that all food be well chewed and mixed thoroughly with saliva to promote good digestion farther along the digestive tract. Good teeth are of paramount importance.

Since peristalsis and the secretion of digestive juices take place best when you are calm, happy, and not too tired, you should try to establish these conditions for yourself and others, especially at mealtime. Since any kind of worry hinders digestion, avoid it. Worry over digestion can best be avoided by eating a well-balanced diet of well-cooked foods that you know are good for you. Establish correct eating *habits*, then forget your digestive apparatus entirely!

ACTIVITIES

1. Self-check on your study of this problem. See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. A demonstration of osmosis:

a. Stretch a pig bladder over the end of a thistle-tube bulb filled with syrup and submerged in water, or hollow out a fresh carrot, fill with syrup and seal with one-holed rubber stopper with glass tubing extending from top. (Use sealing wax or paraffin to seal.) Submerge in water.

b. Substitute starch and water for syrup in either of the above to prove that solubility in water is necessary for osmosis. Relate this to the purpose of digesting food.

c. Record several processes and places in the body where osmosis must take place.

3. A diagram. Prepare and label a diagram of the human digestive organs, stating briefly the action that takes place in each.

4. Experiments on digestion. Conduct a series of experiments to demonstrate digestive processes (see laboratory manuals for details; see references in the Appendix).

a. The action of saliva on starch.

b. The action of gastric juice on protein and milk.

c. The action of pancreatic juice on starch, fats, and protein.

d. The rapidity of digestion as it is affected by frying and other cooking methods, by the presence of chemicals such as vinegar, and by the thoroughness of chewing.

5. Microscopic study. View slides of sections taken from various digestive organs. Note particularly major layers, glands, and folds.

6. Writing a story. Write, in your best English, a short story entitled "The Adventures of a Ham Sandwich," telling all that happens to it in the body. Include in the sandwich: bread, butter, lettuce, and ham.

7. A report. Give an oral report on "The Relationship between Mouth Health and Bodily Health."

8. Key words. Add these to your word list in your notebook and write briefly your ideas (*not* merely a definition) about each:

alimentary canal
single sugars
fatty acids and glycerine
amino acids
enzymes
pyloric valve
duodenum
villi
colon (including rectum and anus)
colitis
peristalsis
saliva
gastric juice
bile
pancreatic juice
intestinal juice

Your Health Habits

Check yourself on the following habits. Do you —

a. Eat slowly?
b. Chew your food well?
c. Never drink with food in your mouth?
d. Make mealtime a pleasant time?
e. Never eat when too tired, but rest first?
f. Avoid exercise immediately after eating?
g. Avoid ice-cold drinks with meals?
h. Avoid too much rich and greasy food?
i. Eat the correct amount?
j. Avoid foods you know are not good for *you*?
k. Avoid constipation by using natural methods rather than by drugs?
l. Maintain good posture, holding digestive organs in place?

SUGGESTED REFERENCES [1]

Alvares, Walter C., "Nerves and Indigestion," *Hygeia*, September, 1938.

Bishop, Louis F., "Acute Indigestion — or Is It Heart Disease?" *Hygeia*, December, 1938.

Blount, R. E., *The Science of Every Day Health*, Allyn and Bacon, New York, pp. 128–132.

Clendening, Logan, *Health Chats*, David M'cKay, Philadelphia, 1936, pp. 235–236.

Diehl, Harold S., *Healthful Living*,* McGraw-Hill Book Co., Inc., New York, 1941, new ed., rev., Chaps. VI, VII.

Gulick, Luther H., *The Efficient Life*, Doubleday, Doran & Co., New York, 1928, Chaps. VII–X.

—— *Habit Time*, Petrolagar Laboratories, Inc., 536 Lake Shore Dr., Chicago, Ill. (Write for this booklet.)

Hunter, George W., *Problems in Biology*, American Book Company, New York, 1935, pp. 369–380.

Liehan, Louis, "That Right-sided Pain," *Hygeia*, March, 1939.

Sure, Barnett, *The Little Things in Life*, D. Appleton-Century Co., New York, 1936.

[1] Use also biology, physiology, or hygiene texts. See references in the Appendix.

* For advanced pupils and teachers.

Unit III. *Keeping the Blood Stream Active*

IF YOU were asked, "What physical conditions alarm you most?" you would probably agree that they were *severe bleeding* and an *unstable heartbeat.* Everyone knows that his very life depends on the conservation of his blood and the constant pumping of his heart. Yet very few people realize that daily health and vitality also depend almost entirely upon the composition and flow of the blood stream.

An understanding of the circulatory system is so vital that modern medical and health sciences are founded upon it. These sciences could have made little progress without a clear idea as to how the blood circulates, and the many functions it performs en route. These vitally important fundamental ideas are presented in this unit. Before proceeding with the study of them, however, review the brief description of the circulatory system, page 31.

Problem 6. *What Quality and Quantity of Blood Do You Need?*

Blood is a juice of rarest quality.— GOETHE, *Faust*

STUDY OUTLINE

A. The nature of your blood
   1. Red corpuscles, white corpuscles — what are they? What are the purposes and life story of each?
   2. What is a "blood count"? How many red and white corpuscles should you have?
   3. How is "red" blood different from "blue" blood? Is it different blood?
   4. Why does strangulation cause the body to turn blue?
   5. When pus forms in a wound, what does it indicate? Is it dangerous?
   6. Where does the blood pick up the various substances in it? In what form are they? What are they for?
   7. How is the liquid in a water blister produced?

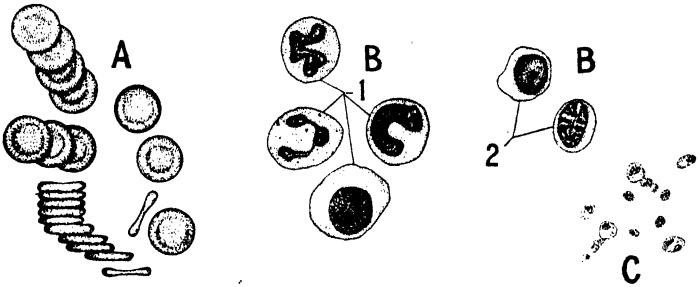
B. Coagulation
   1. Why does bleeding from a small cut usually stop of its own accord? If it doesn't, how can you help stop it?
   2. Is it serious to be a "bleeder"? What causes it?
   3. What do surgeons do to help prevent hemorrhage during and after an operation?
   4. How much blood is in your body? How much could you probably lose safely?
   5. How are blood transfusions performed? Why does it matter what type of blood is used?

TO THE unthinking, blood is a simple substance, similar to water. But when you realize the multitude of different kinds of cells it must nourish and cleanse, you may well suspect that it contains a wide variety of materials. There are two ways of studying its contents: (1) By looking at it under a microscope, and (2) by analyzing it to determine the chemicals of which it is composed.

THE NATURE OF BLOOD

Let us put a drop of bright-red blood on a slide and examine it with a microscope.

"Why," you exclaim, "I don't see anything red at all! All I can see is a colorless liquid with hundreds of pale-yellow, penny-shaped specks and a few colorless, amebalike things floating in it."



30 Corpuscles in the blood. *A*. Red corpuscles. The chains, like stacks of pennies, are called "rouleaux." *B*. Some types of white corpuscles (B_1, leukocytes; B_2, lymphocytes). *C*. Blood platelets. What is the purpose of each? See pages 107, 108, 111, and 112.

Yes, that is about all you can see unless you wait a few minutes and look again with a very high magnification. Then you may see some fine solid threads forming a tangled network around all of the solid bodies.

Red corpuscles. The pale-yellow disk-shaped structures in the blood are the *red corpuscles*. They are so tiny that singly they appear yellow, but when collected in a mass they are red. They are slightly hollowed in the middle, so that there appears to be a spot in the center of each. When blood is drawn from the body, these corpuscles form in rows, their flat sides sticking together, as shown in Fig. 30A. Red corpuscles are remarkably uniform in size in all animals of the same species. Human corpuscles are so small you could get about 5,000,000 in a space the size of the tip of your lead pencil. It has been estimated that you have about 20,000,000,000,000 (twenty trillion) red corpuscles in your body.

The coloring matter in red corpuscles, called hemoglobin (hē′mo-glō′bĭn), is the most important part of the corpuscle. It readily unites with oxygen in the lungs, and as readily gives up oxygen to the cells where it is needed. It also takes up carbon dioxide from around the cells and later releases it in the lungs. Corpuscles which have lost their hemoglobin are worthless because they cannot carry oxygen or carbon dioxide. Some things which may cause destruction of hemoglobin are poisons of certain snakes, some bacteria, and alcohol, bile, acids, and alkalies in certain forms and amounts.

When the corpuscles have a load of carbon dioxide (on the way from body cells to lungs), the blood is bluish red. But as soon as the corpuscles reach the lungs and trade their carbon dioxide for oxygen, they become bright red. What color is blood in the body veins? In the veins from heart to lungs? Why? Examine the arteries in Fig. 36. Is blood the same color in all of them?

All of the blood is sent to the lungs for purification and out again to the body about once every minute. This remarkably efficient arrangement insures an adequate supply of oxygen to all cells, and a swift removal of carbon dioxide from them.

Origin and fate of red corpuscles. Red corpuscles of mammals are cells which have lost their nuclei and hence can no longer be thought of as living cells. They are constantly being formed in the red marrow of the long bones, near joints of arms and legs. The cells of these corpuscle-forming tissues are continually dividing, and the newly formed cells store up hemoglobin, lose their nuclei, and float off into the blood stream. Here they live the whole of their extremely active lives, never going outside this network of tubes.

The life of the red corpuscles is so strenuous that they wear out in from 20 to 60 days. Thus millions of them break up daily and must be removed from circulation. It is believed that they are taken out, or "eaten," chiefly by certain very large cells found in the spleen.[1] These cells are called *macrophages* (măk′rō-fājs) (Fig. 31). They propel themselves about in the pools of blood in the spongy spaces of the spleen, devouring germs, foreign particles, and fragments of broken-down red corpuscles.

It is not certain whether the macrophages completely disintegrate the worn-out red corpuscles or merely prepare them for de-

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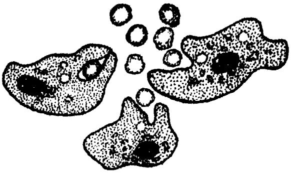
[1] The spleen is a spongy, bean-shaped organ situated at the left of the stomach. Its functions are only partly understood.



31 Wrecking ground of worn-out red corpuscles. Macrophages of the spleen attacking red blood cells.

struction by the liver. It is known, however, that the valuable iron of the corpuscles is returned to the blood to be used by the bone marrow in the manufacture of more red corpuscles. The remaining waste parts of dead corpuscles are used by the liver in making bile.

Anemia. In this diseased condition there is a decrease either in the *number of red corpuscles* or in the *amount of hemoglobin* contained in the corpuscles. Persons suffering from anemia usually are pale because the blood is not so red; they are thin because there is not enough oxygen to unite with food and change it into living substance; and they tire easily because the food cannot be oxidized in the cells to release energy.

Anemia may be of two types. "Simple" anemia usually results from some abnormal condition which destroys some of the red blood corpuscles or weakens the body's blood-building powers. To overcome this type of anemia the patient merely has to be cured of the condition causing it; then the body's corpuscle-building agencies will soon replenish the blood stream.

In "pernicious" anemia the body cannot produce sufficient red corpuscles because the liver lacks something that is necessary for the manufacture of hemoglobin. The exact nature of this essential element in the liver is not yet known; its discovery, in 1925, however, marks one of the high points in medical history. Before that time, pernicious anemia meant certain death; since then, death from this cause is very rare, for animal liver relieves it.

Your hemoglobin. You may easily determine your hemoglobin content by placing a drop of your blood on a piece of thin, absorbent paper and quickly comparing the color with the printed color scale which your teacher can probably furnish you (a hemoglobinometer). On this scale, normal individuals usually rate between 85 per cent and 100 per cent. If your hemoglobin content is below 85 per cent, it is advisable to eat foods rich in iron; if it is below 70 per cent, you should see a doctor.

How many red corpuscles have you? There is naturally a certain variation in the number of red corpuscles in the blood. The average for the adult man is about 5,000,000 in a cubic millimeter, and for the adult woman about 4,500,000. The number is "counted" by drawing an accurately measured volume of blood from the ear or finger tip, then diluting this to a known volume and actually counting the corpuscles in this known amount of diluted blood under the microscope (Fig. 32). From this count, the total number of red corpuscles in any volume of diluted blood can be calculated.

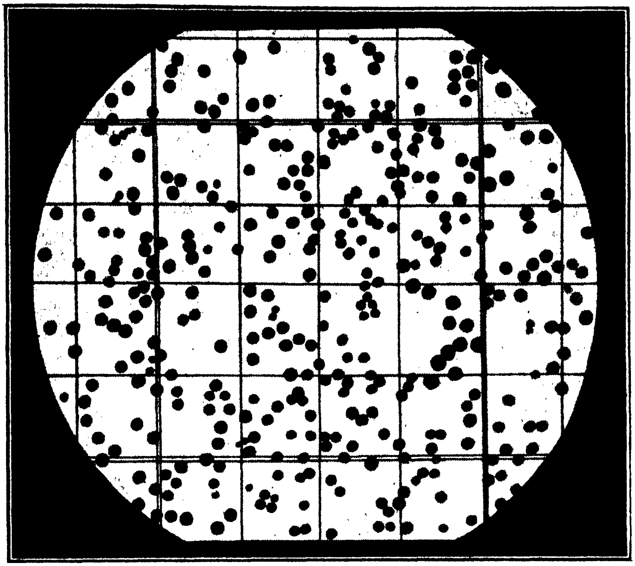
If your teacher can supply you with the necessary instructions and apparatus, you will be interested in making a count of red corpuscles as well as the hemoglobin test. Remember, they are different, for the "count" will tell you only the actual number of red corpuscles in the blood, while the hemoglobin test will show the percentage of this vitally important red coloring matter in the cells.

Effect of altitude on manufacture of red corpuscles. If you go from low to high altitude, you will find that your heart beats faster and that you become "winded" with a fraction of the exercise you can perform easily nearer sea level. The reason is that there is less oxygen at the higher altitude and therefore the red corpuscles cannot take on as much oxygen when they pass through the lungs. The heart is stimulated to beat faster in order to circulate the red corpuscles more rapidly to supply the oxygen needed by the body cells. For this reason high altitudes are hard on people with weak hearts.

If you stay in the high altitude for several days, you will find that you can do increased muscular work again without undue fatigue. By this time, the red-corpuscle-forming tissue has been stimulated to increase the normal production in order to make up for the decreased amount of oxygen in the air.

White corpuscles. These are the ameba-shaped bodies you observe in the microscope when you look at the blood. They are really colorless, not white. In a healthy person there are about 5,000 to 7,000 of them in each cubic millimeter of blood, or about one white corpuscle to every 600 or 700 red corpuscles. The proportion may, however, vary a great deal. Their size also varies greatly, though most of them are about one third larger than red corpuscles.

The white corpuscles are living cells containing one or more nuclei (Fig. 30B). The granules in the protoplasm of some may hide the nuclei, but a drop of acetic acid (vinegar) on your slide will dissolve the granules and bring the nucleus into view. These corpuscles are not much different from the simple one-celled ameba.

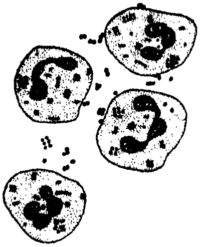


32 Red blood cells as seen under the microscope in laboratory counting chamber. Each small square contains a known amount of blood. Counting the average number of red corpuscles per square is not difficult. Try it. (Courtesy of Dr. R. V. Stone, Los Angeles County Health Department)

Most of them are capable of changing shape in such a way as to move or creep along and engulf particles. To observe this with the microscope, the blood on the slide must be kept at body temperature.

There are several different kinds of white corpuscles. One type, called *lymphocyte* (lĭm′fō-sīt), is produced in large numbers in the lymph nodes (page 128) and carried by the lymph into the blood stream. It is believed that these corpuscles disappear constantly from the blood through the surface of the mucous membranes, particularly in the intestine, where they may aid digestion and protect the body from infection.

Another type, called *leukocytes* (lū′kō-sīts), have an amebalike motion. They bore their way right through the capillary walls



33 Leukocytes engulfing bacteria. Why would it be dangerous to have a low white-blood-cell count?

and creep about in the spaces between cells in the various tissues. Most of them engulf and destroy bacteria (Fig. 33). Some produce special substances to counteract certain poisons such as snake venom. Still others engulf larger particles such as destroyed portions of cut or bruised cells. Why are leukocytes particularly important to persons recovering from illness or accident?

Nature of pus and abscesses. Whenever the skin is cut or punctured and germs enter the tissues beneath it, the body's reserve army of white blood corpuscles is instantly called into action by some unknown means. Millions of them hasten to the infected spot and attack the germs. The battle field around it is strewn with dead germs, corpuscles, and cells, which together with some lymph form the yellowish matter known as *pus.* The dead tissue forms a hard core which is surrounded by pus. This local condition is known as an *abscess.* The hordes of white corpuscles in the abscess usually prevent the living germs from entering the blood. Nevertheless, in some cases germs do enter the blood, causing an infection which may result in death. If even a small scratch causes fever, a doctor should be consulted at once.

White-blood-cell count. White corpuscles are counted in much the same way as red ones, and the knowledge of their number is often of great importance to the physician in making an accurate diagnosis. An increase in these corpuscles often indicates some infection because white corpuscles are produced faster when there are more bacteria against which they must fight. In many cases, the white-blood-cell count is the only way by which the doctor can determine that certain symptoms are caused by a hidden infection. This may be from abscessed teeth, appendicitis, diseased tonsils, or some other infected part of the body which gives no pain or outward sign of trouble. A count of more than 10,000 per cubic millimeter is considered an indication of an abnormal condition. A decrease in the number of white corpuscles is a characteristic symptom of typhoid fever, tuberculosis, and certain other diseases.

Blood platelets. The blood also contains tiny, colorless, flat bodies with irregular edges, as shown in Fig. 30C. These are called *platelets*. They remained undiscovered for a long time because they break up when they come in contact with air or with a surface other than the lining of the blood vessels. They are smaller than red corpuscles and are only about one tenth as numerous. They are important in helping blood to clot.

Thus the microscope reveals (1) the disk-shaped, uniform *red corpuscles*; (2) several varieties of *white corpuscles* of irregular shapes and sizes; and (3) the smaller *blood platelets*, which are apparent only when the blood has not come in contact with air. Besides these, the blood contains many things which are not visible even with the most powerful microscope because they are dissolved. These can be detected only by a chemical analysis. They are discussed in the remainder of this section.

Plasma — the liquid of the blood. The liquid in which the corpuscles float is called *plasma* (plăz′mȧ). It contains all of the substances the blood needs to carry on its many functions. The plasma is about 90 per cent water, in which are dissolved more than a hundred substances. Chief among these are: (1) *food materials*, which consist of relatively small amounts of protein substances (amino acids), about 0.10 to 0.12 per cent of sugar (glucose), and a varying amount of fat according to the richness of the meal just eaten; (2) *waste materials*, most important of which are urea and uric acid; (3) *blood proteins*, among which is a substance for clotting the blood; (4) *hormones*, which are the secretions of the endocrine glands that regulate life processes; (5) *disease-resisting substances*, which are produced by the blood itself; (6) *dissolved gases*, which consist of limited amounts of oxygen, nitrogen, and carbon dioxide; and (7) *inorganic compounds*, which consist mostly of sodium, potassium, and calcium salts, with the sodium salts in the largest quantity.

An important fact about the plasma is that it should and does remain slightly alkaline or nearly neutral in reaction. Recent tests have shown that the blood has a wonderful stability which is as yet unexplained. Regardless of what happens to your body, if you are a normal person, your blood so regulates itself as to maintain about the same reaction, as far as acidity and alkalinity are concerned. It takes a long time to change it either one way or the other.

Lymph — the liquid in the tissues. When the plasma passes outside the capillary walls into the spaces between the cells, it is called *lymph.* The water which collects between layers of the skin to form a blister is a good example of lymph. You may be familiar with the fact that this fluid has a salty taste. Lymph is slightly alkaline and the chief difference between lymph and plasma is that lymph contains more wastes and less food material than plasma. Can you explain why this should be? (Reread page 32.)

Lymph contains carbon dioxide in solution but practically no oxygen, for the oxygen is taken up by the living cells as fast as it enters the lymph from the blood. During digestion the lymph from around the intestines is white and milky because of the digested fats it contains; during fasting it is colorless.

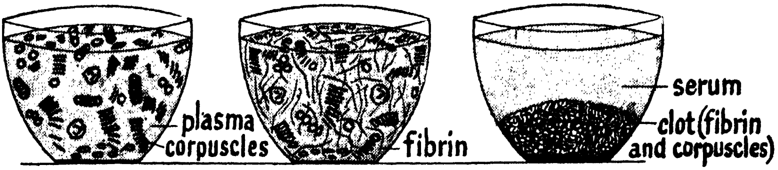
When examined under a microscope, lymph is found to have many white corpuscles floating in it, some of which have wandered from the blood into the lymph tissue.

Lymph fills most of the "in-between" spaces in the body. Sometimes it is given a special name according to its location. For instance, the liquid in the spaces between cells is called *tissue fluid;* that which lubricates the bones at the joints is known as *synovial* (sĭ-nō′vĭ-*ă*l) *fluid;* and that which is between the heart and the saclike membrane in which it is contained is called *pericardial* (pĕr′ĭ-kär′dĭ-*ă*l) *fluid.* Regardless of name, however, this colorless fluid is similar in chemical composition wherever it is found.

COAGULATION

A cut, or even a scratch, would have resulted in your death in babyhood had not nature provided your blood with means for forming a clot to plug up the wound. By studying this phenomenon scientists have discovered how to help your blood clot faster if necessary. They have also learned how to *prevent* blood from clotting so that it may be taken from healthy persons and sent across seas or snowy wastes to save the lives of other human beings far away.

How a blood clot is formed. It is not known exactly what causes blood to clot, but, briefly, this is what happens: When blood comes in contact with air or a foreign surface it separates into its liquid (*serum*) and nonliquid constituents. By the action of some chemi-



34 Steps in the clotting of blood. Fibrin makes up the fine threads shown in the center drawing. It is formed from a chemical, fibrinogen, in the blood. The fibrin threads enmesh the corpuscles, thus forming a clot. Under what conditions will a clot start to form? (See text.)

cals[1] normally present in the blood, the nonliquid parts collect (coagulate) and form the clot, as shown in Fig. 34.

Coagulation time. The length of time it takes for a person's blood to clot — the coagulation time — is a very important thing to know before an operation. This is a precaution against hemorrhage, especially before the removal of tonsils. If a person's blood does not clot quickly enough, he may be fed vitamin K (page 62) or a special calcium compound for a week, then have another test made. Recent experiments indicate that fruit pectin, also, may be valuable for this purpose.

"Bleeders" — hemophilia. The blood of certain individuals does not coagulate readily. Such people are in danger of bleeding to death from even a small cut. This condition is called *hemophilia* (hē′mō-fĭl′ĭ-ȧ). It is a hereditary trait.[2] We are familiar with it through its prevalence in the males of the last royal family which ruled in Spain. At present no cure is known for this affliction.

How much blood could you lose safely? The blood constitutes approximately $\frac{1}{13}$ of the total body weight, or about 10 to 12 pints. It is probable that a healthy adult could recover from the loss of nearly one third of the total amount of blood, or about 3 or 4 pints. It has been shown that the plasma regains its normal volume in from 24 to 48 hours after a severe loss of blood; but the number of red corpuscles and the amount of hemoglobin are restored more slowly, getting back to normal after 4 to 8 weeks.

When there is an urgent need for more fluid in the blood, a salt solution is often injected directly into a vein or between the layers of skin, from which it is rapidly absorbed into the blood stream.[1] When a patient's life depends on having an increased number of corpuscles or a serum to help him combat a certain disease, the blood of another person — usually one pint — may be transferred to him by transfusion.

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[1] The complicated process of clotting requires *fibrinogen* (fī-brĭn′ō-jĕn), calcium, and a certain substance liberated by disintegrated platelets. Several intermediary chemicals are formed in the process.

[2] This trait appears only in males in a family but is transmitted to the next generation only by females.

Blood transfusion. The early attempts to treat disease by blood transfusion were often fatal because the blood clotted. The discovery of the blood platelets and their role in blood clotting was of vital importance. It indicated that clotting could be avoided if the blood could be transferred without exposing it at any time to air or a foreign surface. Accordingly, an ingenious method was developed whereby a blood vessel of one individual could be brought into direct contact with the vein of another. The blood was thus allowed to flow directly through the channel.

During the first World War it was discovered that if the surfaces of all syringe needles and receiving vessels were thoroughly oiled or paraffined, the platelets would not disintegrate. Blood could then be drawn directly from the one who gives the blood — the donor — set aside for a few minutes if necessary, and then injected directly into the veins of the patient. Still later it was discovered that if certain chemicals were added to the blood it could be kept for some time without danger of coagulation when injected into the patient. Large hospitals now prepare for emergencies by keeping a supply of blood in refrigerators. This type of storage of blood is referred to as "blood bank."

Types of human blood. Not all human bloods can be mixed without the danger of clotting, since there are four different types. Before blood is used for a transfusion, a laboratory test is necessary to make certain that the blood type of the two persons is identical. In addition, tests are made to determine that the donor is healthy so that no disease will be transmitted to the receiver.

It is interesting to note that of the four types of human blood, 10 per cent of adults fall into Group I, 40 per cent into Group II, 7 per cent into Group III, and 43 per cent into Group IV. Usually the blood of closely related members of the same family falls into the same group, and often the blood of relatives can be used when it is offered for transfusions.

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[1] A "physiological salt solution" (a 0.9 per cent solution or about one level teaspoonful salt to one pint of water) is approximately the basis of all body fluids. It does not cause red corpuscles to lose their hemoglobin, and does not irritate tissues. Hence it may be used safely as an eyewash or an enema.

Conclusion. Blood plasma is a complex liquid containing more than a hundred substances, which constitute all the needed chemicals and the wastes of all the body cells and fibrinogen to aid in forming clots. In the plasma float: (1) *red corpuscles* for carrying oxygen from lungs to cells and carbon dioxide from cells to lungs; (2) a large variety of *white corpuscles* for combating foreign bodies and for helping to prepare building foods for all cells; and (3) *blood platelets* for aiding in the process of clotting. No wonder the blood has been called the "life stream" and its composition is of primary importance to health!

Your Health Habits

Check yourself on the following habits. Do you —

a. Refrain from fear and worry over a moderate loss of blood?

b. Eat sufficient foods containing iron for building red corpuscles? (See Problem 3.)

c. Have a doctor attend to all abscesses or injuries showing the presence of pus, especially if there is fever present?

ACTIVITIES

1. Self-check on your study of this problem. See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. Microscopic study of blood. To get a drop of blood, *sterilize the end of your finger with alcohol,* then prick it quickly with a needle *sterilized in a flame. Sterilize finger again after securing blood.* Place a drop of blood on a clean slide and smear it evenly and thinly with the edge of another slide. Place a cover glass on it. Examine with the low- and high-power lens of the microscope. To prevent material from drying, occasionally add a drop of normal salt solution (see footnote, page 116).

3. Testing hemoglobin. Estimate the percentage of hemoglobin in your own blood. In getting sample of blood, *be sure to sterilize finger and needle as in Activity* 2. For directions see page 109.

4. Reports. Make a report on one of the following topics:

a. *The discovery of the liver treatment for anemia.* This interesting story is told in many books on the history of medical science. For an especially good account, see Paul de Kruif's *Men Against Death.*

b. *Metchnikoff's discovery of white-corpuscle functions.* The story of how this excitable Austrian discovered that white corpuscles "cleanse" the blood by their "scavenger" action is told in nearly all books on the history of medical science (see References in the Appendix).

c. *Blood transfusions.* Tell instances where they are given and describe latest methods used.

5. Key words. Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each:

red corpuscles
anemia
hemoglobin
white corpuscles
plasma
lymph
coagulation of blood
blood transfusions

SUGGESTED REFERENCES[1]

"Blood Plasma for Britain Given by U. S. Donors under Red Cross Program," *Life,* Oct. 21, 1940.

Clendening, Logan, *Health Chats,* David McKay Co., Philadelphia, 1936, pp. 206–211.

Jansky and Moss, "Blood Donors," *Hygeia,* July, 1938.

Johnson, A. S., "Anemia, Its Causes and Treatment," *Hygeia,* April, 1937.

Ratcliff, J. D., "They Need Not Die; Newly Discovered Vitamin K Stops Fatal Hemorrhages," *Readers' Digest,* November, 1940.

—— "Stored Blood for Transfusions," *Literary Digest,* Nov. 20, 1937.

—— "Treatment of the Blood Disease, Leukemia," *Science Digest,* March, 1941.

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[1] Use also books in *General References* in the Appendix.

Problem 7. *How Does the Blood Flow through the Body?*

> That which cometh from the heart will go to the heart.
>
> — JEREMIAH BURROUGHS

STUDY OUTLINE

A. The red network
  1. How fast does blood circulate through the body?
  2. What main routes does it follow?
  3. Does it deliver materials directly to the cells?

B. How the blood flow is regulated
  1. Do you count your pulse by a vein or artery? Why?
  2. Does the blood stream stop moving between heartbeats?
  3. How can the digestive organs get more blood after a meal, and the muscles more while exercising?
  4. What causes blushing and fainting?
  5. Why does blood flow steadily from some wounds and spurt from others?

C. Where the lymph goes
  1. What can you do to help keep the lymph moving?
  2. What are the painful "lumps" you sometimes feel in your neck? What should you do about such swellings?

D. How to avoid conditions that interfere with circulation
  1. What happens if the blood stops moving in any part of the body?
  2. What are varicose veins? Cause? Cure? Prevention?
  3. What is each: high blood pressure, hardening of the arteries, low blood pressure? Causes of each? How prevented? Is there a cure?
  4. How can you stimulate circulation?

IT SEEMS incredible that human beings for thousands of years felt their hearts beat, observed their pulse rhythm, and saw blood ooze and spurt from wounds — and still never learned that the blood was pumped by the heart and that it circulated through the body. Although much speculation occurred concerning the matter, the true concept was not developed until the seventeenth century, when William Harvey conceived it and proved it by experiment.

THE RED NETWORK

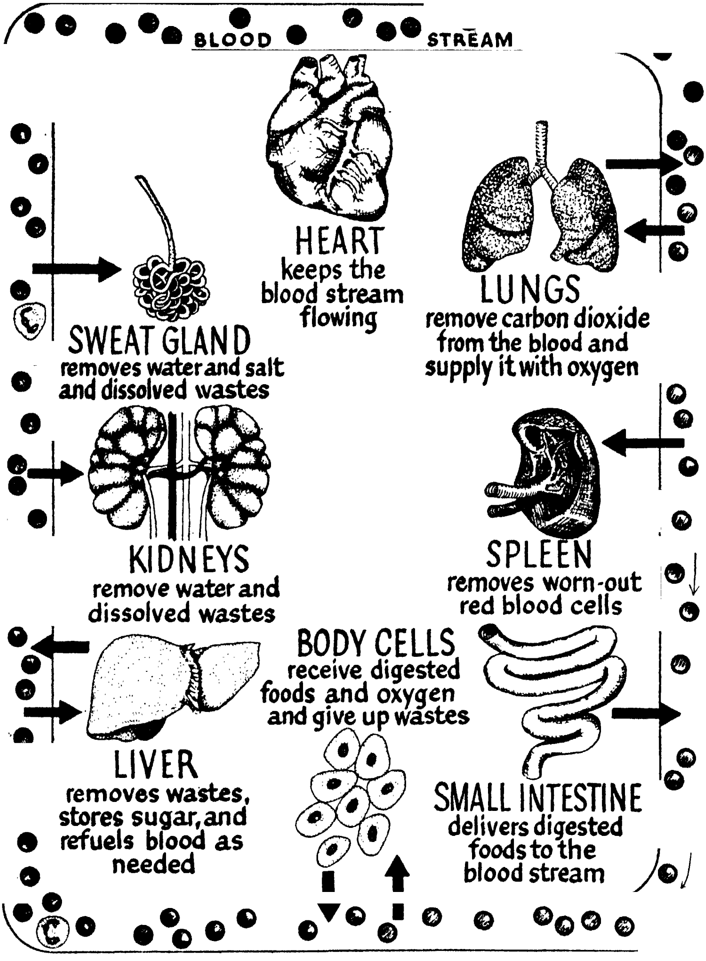
It is almost unbelievable that the heart pumps each drop of blood to some part of the body and back again in less than a minute. Every artery carrying blood away from the heart branches into a network of capillaries which unite to form veins that return the blood to the heart. Study Figs. 36 and 39 carefully. Of necessity there can be only one-way traffic in the blood vessels, and no blind alleys. This is extremely important, for the flow of blood must not be blocked anywhere. Can you tell why? (Study Fig. 35.)

Where the blood takes on oxygen. The blood makes a special trip from the heart to the lungs (the *pulmonary circulation*) to deliver its load of carbon dioxide and pick up fresh oxygen. As you will notice in Fig. 36, the heart is divided into two similar pumps. The *right* side of the heart receives blood from two great veins called the *venae cavae* (vē′nē kā′vē) and pumps it to the lungs through the pulmonary artery.

In the lungs the artery breaks up into a network of capillaries which encircle the tiny sacs containing air. Carbon dioxide and oxygen are exchanged by osmosis through the walls of the air sacs and capillaries. The capillaries then unite to form the pulmonary veins, which return the blood to the *left* side of the heart. What is the difference between blood leaving the right side of the heart and that entering at the left side?

How the blood reaches the cells. The blood is now ready to be sent, with its fresh load of oxygen, to all parts of the body. Follow its path in Fig. 36. Find where the left side of the heart pumps the blood out through the great *aorta* (ā-ôr′tȧ). This is the largest artery in the body. Note that its main branches carry blood to the head, arms, spleen, stomach, pancreas, liver, small intestines, colon, kidneys, reproductive organs, and the legs. A network of capillaries distributes the blood to the body tissues, whence it is returned to the heart by way of the veins, and thence again to the lungs for purification.

Where the blood takes on food. You may have noticed in Fig. 36


BLOOD STREAM
HEART
keeps the blood stream flowing
LUNGS
remove carbon dioxide from the blood and supply it with oxygen
SWEAT GLAND
removes water and salt and dissolved wastes
KIDNEYS
remove water and dissolved wastes
SPLEEN
removes worn-out red blood cells
BODY CELLS
receive digested foods and oxygen and give up wastes
LIVER
removes wastes, stores sugar, and refuels blood as needed
SMALL INTESTINE
delivers digested foods to the blood stream

35 The blood stream is the transportation system of the body. It receives various materials from many organs and delivers them to other parts of the body. This diagram shows what materials are exchanged in a few important organs. How would the whole body suffer if the circulation were poor around the intestines? or through the liver? How would the cells of the legs (body cells) suffer if blood did not circulate well through them? (*Hint:* What does each of these organs add to, or take from, the blood stream?)

that the blood path around the digestive organs does not follow the same pattern as through other organs. After it has picked up its cargo of digested food, the blood does *not* go directly back to the heart. It must pass first through the liver. There is a good reason for this indirect route, for the liver is a great cleansing machine and storehouse. It purifies the blood coming from the intestine and stores some of the incoming food. It controls the normal amount of glucose (sugar) in the blood at all times.

Note that the liver also has an artery entering it *directly* from the aorta. This artery carries oxygen-laden blood to supply the needs of the hard-working liver cells.

HOW THE BLOOD FLOW IS REGULATED

In order to meet your body's needs, the blood stream must be capable of instant and automatic regulation, sending more blood to working organs when they need it. Nature has provided an intricate system, which works on the principle of changing the actual size of blood vessels and the pressure within them as the circumstances demand. Let us see how such a system is possible.

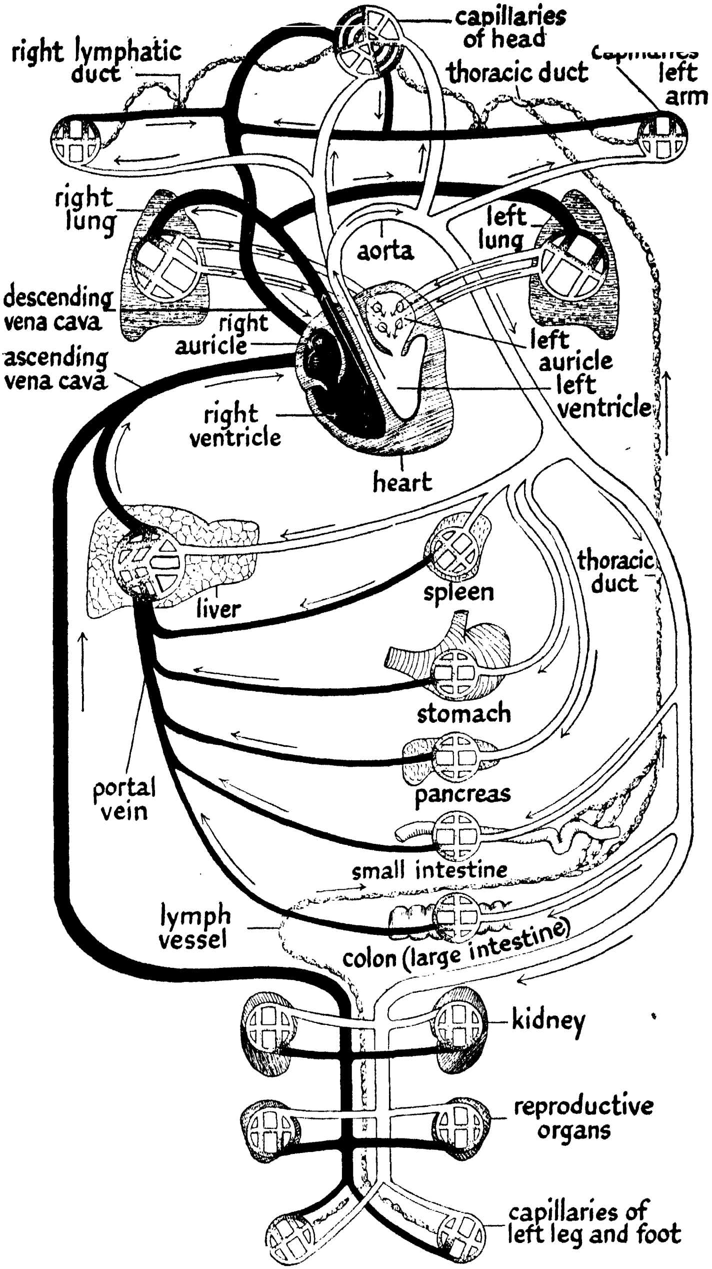
How blood vessels are constructed. The tubes through which the blood circulates in the body vary in size and structure, each kind fitted to play its particular part in the circulatory process as follows:

Arteries — carriers of blood under pressure. Arteries carry blood *from* the heart. Their walls are composed of three layers: (1) an outer coat of dense white connective tissue, (2) a middle layer of smooth-muscle cells circularly arranged around the vessel, and (3) an inner lining of delicate epithelium.

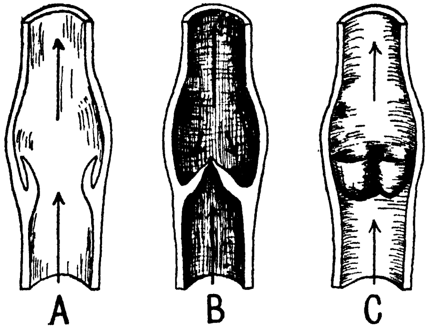
The strength of an artery depends on the thickness of the outer coat which is heavier in the large arteries. This prevents the arteries from collapsing when cut. This factor, in addition to the blood pressure from the contraction of the heart and arterial muscles, makes it difficult to stop bleeding from an artery.

The middle layer of the arterial muscles contains elastic fibers among the muscle cells. These fibers enable the arteries to stretch or shrink, depending on the amount of blood forced through them with each heartbeat. The smaller arteries are called *arterioles* (är-tē′rĭ-ōls). When arteries have lost their elasticity they are said to have "hardened"; this condition is known as *hardening of the arteries*. It is discussed on page 130.

Capillaries — where the real "work" of the blood is done. The outer two layers of the arteries become thinner and thinner as the



36 The main blood and lymph vessels of the body. The aorta and ascending vena cava really lie close together in front of the spinal column. They are widely separated here only to make the general idea more clear.



37 Pocket valves in veins. *A*. Valves open owing to forward pressure of blood. *B*. Valves closed owing to backward pressure, hence backward flow is prevented. *C*. Section to show cup-shaped construction of valves.

tubes grow smaller in diameter. When only the inner coat remains, these vessels become *capillaries* (see Fig. 39). The capillaries form interlacing networks of varying sizes in every tissue of the body except cartilage, hair, nails, cuticle, and part of the front covering (cornea) of the eyeball. The parts just named do not need capillaries because they are not live tissue. All live cells, however, must be nourished from a nearby capillary through whose thin walls materials are constantly being exchanged. These tiny blood vessels can be seen only with the aid of a microscope. They average about $\frac{1}{25}$ inch in length and their diameter is so small that the corpuscles must pass through them in single file.

Veins — valved pipes. After leaving the capillaries, the blood returns to the heart by way of the veins. The smallest veins, called venules (vĕn′ūls), are formed by the uniting of the capillaries. Veins do not have such thick walls as arteries, and they cannot stretch and shrink of their own accord to the same extent as arteries. When cut, the walls of a vein collapse, and it is relatively easy to stop the bleeding from it by outside pressure upon the tube.

The larger veins contain valves which permit the blood to flow toward, but not away from, the heart. As you see in Fig. 37, the valves usually consist of a pair of cups made of tough membrane. These cups open up like tiny parachutes and prevent a backflow when the blood pressure becomes greater on their hollow side. To locate a valve, let your arm hang down until the veins are slightly distended. Then press downward on one of the prominent veins on the back of the hand. Do you see that where there is a valve the vein bulges on the side toward your heart?

Your nerves and your circulation — vasomotor control. Nerve impulses constantly travel from your brain and spinal cord to the tiny muscles in the walls of the small arteries of your body. Certain nerves stimulate the muscles to contract and make the arterioles smaller or constricted. This cuts down the blood supply to those particular arterioles and also to the capillaries leading from them. Can you now explain how these nerves make you turn pale from sudden fear? The nerves which cause such constriction of the blood vessels are called *vasoconstrictors* (văs′ō̇-kŏn-strĭk′tẽrs, from *vas* = vessel + *constrictor*).

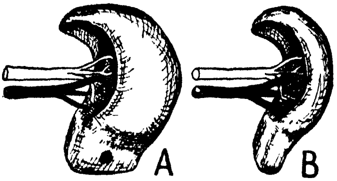
When you blush, the opposite effect takes place. Another set of nerves relaxes the muscles, thus dilating, or making the blood vessels larger. This permits more blood to enter them and your cheeks become pink. Such nerves are called *vasodilators* (văs′ō̇-dĭ-lā′tẽrs).

Both sets of nerves, constrictors and dilators, together are called *vasomotor* nerves. Remembering that "motor" means "that which moves," why is this name appropriate for these nerves?

Your vasomotor nerves are extremely important, for they are the headgates which are continually shifting so as to keep your blood flow regulated according to the particular needs of your body. The general principle upon which they work is to *dilate the blood vessels in the organs that are being used and to contract those in the inactive organs.* For example, when you exercise, more blood is allowed to flow to your muscles, at the expense of your internal organs. Also, after a heavy meal, more blood flows to your digestive system and less to your brain, so that you feel sleepy and cannot think so well.

The vasomotor nerves are stimulated not only by *thoughts* but also by *sensations* (nerve impulses from things you see, hear, feel, taste, or smell), and by *chemicals* in the blood (mostly carbon dioxide, lactic acid, and adrenalin). By these three means adjustments are constantly being made in your blood flow, though most of the time you are entirely unconscious of them.

The spleen as a reservoir for blood. When a great many vessels are dilated, more blood is required to fill them than can be supplied by a mere constriction of other vessels. This extra quantity of blood for emergencies is provided mostly by the spleen (see footnote, page 108). This organ is about the size of your fist, but its spongelike structure enables it to hold as much as one fifth of the total amount of blood in the body. Many bands of muscle pass



38 The spleen, a reservoir for blood. *A*. Filled with blood. *B*. Contracted.

through and encircle it so that their contraction squeezes blood out of it as out of a sponge (Fig. 38). This squeezing action takes place when the body needs more blood or more red corpuscles — at high altitudes, at high temperatures, in cases of carbon monoxide poisoning, or during exercise. Thus the spleen acts as a reservoir for extra blood.

The meaning of blood pressure. You probably hear a good deal about "blood pressure," yet few people have any idea as to its real meaning and cause. Although it is defined as "the pressure the blood exerts against the walls of the blood vessels," this needs explanation.

One reason the blood has pressure is because the *heart* puts pressure upon it. With each beat the heart forces some blood into the aorta in a powerful spurt at great speed. This gives all the blood in the circulation a little push forward, but not with as much force as in the aorta because of the following facts:

Immediately after leaving the heart the blood may travel as fast as 12 inches per second. As the arteries branch and rebranch, the blood spreads out and gradually travels less rapidly because of the resistance of the smaller vessels. By the time the blood reaches the millions of tiny capillaries, it moves only about $\frac{1}{600}$ as fast as in the aorta. It cannot be forced ahead much faster no matter how hard the heart beats. This *resistance of the capillaries* causes the blood to back up momentarily under pressure in the arteries, and is a second factor in blood pressure.

Heart beat and resistance to flow do not account for all blood pressure, for the blood keeps flowing forward even between beats, when the heart is putting no pressure whatever behind it. This remarkable phenomenon is made possible by the *elasticity* and *muscular action of the arteries*. These vessels stretch to make room for each new spurt of blood and then contract behind it in such a way as to keep the blood moving forward by peristaltic action similar to that in the intestinal tract (page 91).

Can you now summarize the three factors which determine your blood pressure? Can you also explain the fact that blood pressure is highest in the aorta and is gradually used up until in the vena cava, at the end of the circuit, it is about the same as the air pressure outside the body?

Your pulse. Doubtless you already know that when you count anyone's *pulse* you are really counting his heart rate. The throbbing you feel in the arteries of his wrist, neck, or temples is the pulsation of the blood, alternately strong and weak, caused by the contractions of the arterial muscles in the same rhythm as that of the heart. From the pulse an experienced physician can also tell much about a patient's blood pressure and the condition of his arteries.

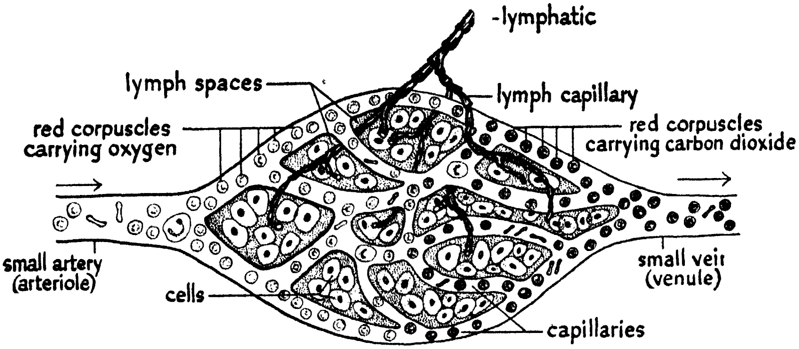
Normal blood pressure. On the scale used to measure blood pressure the gauge should stand at about 75 to 90 for children and adolescents, 100 to 130 for young adults, and 130 to 150 for older people. If it registers a great deal more or less than normal, the person is said to have "high" or "low" blood pressure. The many causes and effects of these ills are discussed on page 130.

WHERE THE LYMPH GOES

You recall that the lymph is continually being formed by the passage of the fluid part of the blood from the capillaries into the spaces between the cells. It is evident that this fluid cannot accumulate indefinitely. Why would your body swell up if the lymph remained in the tissues? Lymph must also be kept moving *away* from the cells in order to carry away their wastes and prevent these from poisoning the cells, and it must return to the blood stream to replenish the liquid part of the blood.

Lymph vessels. Lymph returns to the main blood stream by a system of vessels called *lymphatics* (lĭm-făt′ĭks). Note on Fig. 39 that tiny lymph vessels drain the lymph from the spaces and unite into larger tubes. From all parts of the body these lymphatics continue to combine until, finally, they form two main vessels: (1) the *thoracic duct*, and (2) the *right lymphatic duct* (see Fig. 36). The right lymphatic duct drains only the upper right quarter of the body. It empties into the blood stream on the right side of the neck. The thoracic duct drains all the rest of the body and empties into the blood stream in the left shoulder.

In the lymphatics, especially where the small ones open into the



39 Where the work of the blood stream is done. How do materials travel from capillaries to cells? (*Hint:* What fills the spaces between them?)

larger ones, there are numerous valves similar to those found in veins. This gives them a jointed appearance, as in Fig. 40. The lymph in the spaces between the cells is slowly pushed into the openings of the lymph vessels by the pressure of the newly formed lymph which is continually seeping out of the capillaries. Muscular exercise helps to push the lymph onward, while the valves prevent it from going backward. This is one of the important benefits of exercise.

Lymph nodes for straining lymph. Along the course of the lymph stream are small saclike enlargements or kernels of fairly dense tissue. These are called *lymph nodes* and are most numerous in the neck, armpits, groin, and abdomen. Microscopic study shows that these nodes act as filters, for the lymph must be forced through tiny spaces between their cells. These aid in combating infection by straining out microbes and other foreign particles which get into the lymph. Consequently, the nodes sometimes become inflamed and enlarged and are painful when touched.

If an infection is severe, some of the foreign particles may get past the nearest nodes and be caught in nodes farther along. This explains why an infection in the foot may cause sore "kernels" to form in the groin. Such nodes protect you against general blood poisoning by preventing germs from getting in the main blood stream. In cases when they become large and painful, the safest thing to do is to call a physician.

40 Lymph vessel with numerous pocket valves.

HOW TO AVOID CONDITIONS THAT INTERFERE WITH CIRCULATION

You cannot live vitally without good circulation. If anything continuously interferes with the blood supply to any part of your body, the cells there will become less efficient and in time will degenerate. In extreme cases they even die, resulting in the condition called *gangrene.* Since each part of the body serves the whole, your general well-being demands an unimpeded flow of blood throughout the entire system.

Maintain good posture. Water cannot flow through a kinked hose and blood cannot force its way through pinched blood vessels. Some posture defects interfere with circulation and may cause many pains and discomforts. Severe pains, sometimes mistaken for neuritis or rheumatism, frequently result from cramped positions which impair the circulation in the abdomen, back, and shoulders.

Wear loose clothing. You cannot afford to wear anything which constricts your lungs, stomach, liver, intestines, or other parts of the body. Tight collars, garters, and armbands are particularly bad because the veins in the neck and limbs are so close to the surface that their blood flow is easily interfered with. Any elastic should be adjustable and no tighter than is necessary. The same is true of footwear, while too close-fitting hatbands frequently cause poor circulation in the scalp.

Exercise to keep your veins normal. Of course, you need exercise for the sake of your whole body, but your veins need it particularly. One of the most noticeable circulatory ills is *varicose veins.* These are enlarged and painful veins occurring most commonly in the legs. They result from breaking down the valves within the veins. As the blood cannot be kept moving forward, the veins finally become badly swollen. To prevent such damage to the veins, (1) get sufficient exercise to keep the blood vessels in good tone; (2) avoid heavy lifting and straining as much as possible, since that forces the blood in the veins backward into the legs; (3) if it is necessary to stand on the feet for long periods, relieve the back pressure in the veins occasionally by moving about a little so that the muscle action will help force the blood out of the legs. If varicose veins do occur, they should not be neglected but should be cared for by a physician.

Be moderate in all things — for the sake of your arteries. When arteries begin to harden, their inner walls break down and a fatty material is deposited in them. Later, this breaks down and is replaced by calcium, which makes them hard. Of course, this causes them to lose their elasticity or power to stretch. The calcium deposits also tend to fill them up so as partially to block the flow of blood. This added resistance raises the blood pressure and causes the heart to pump harder to maintain the circulation.

For the above reasons, *hardening of the arteries* and *high blood pressure* often go hand in hand. These conditions are produced by the natural processes of old age or by unhygienic living. The actual causes are not known, but the following factors appear to contribute to this condition: (1) *intemperate living;* overeating (especially of highly seasoned foods); overworking the body; too prolonged mental work without care for physical hygiene; overworking the emotions — fear, worry, anger, resentment, excitement, etc.; (2) certain *infections* such as syphilis (most frequently cited as a cause); infected teeth; diseased tonsils; and typhoid fever; (3) *poisoning of the system* by lead or excessive alcohol or tobacco; and (4) a *hereditary tendency* in some people.

The only means known for the prevention of these conditions can be given in one word: *moderation* — that attainment of the fine art of living when you seem to have struck a balance in all things. Moderation involves not overworking your muscles or nerves in either work or play, nor overtaxing your digestive system by improper or excessive eating or drinking. It means living serenely and happily, doing your best from day to day, and not worrying or getting excited over the ups and downs of life.

Since hardened arteries and high blood pressure occur to a certain extent in everyone as he grows older, it is well for most middle-aged people to have a periodical (once a year) examination by a competent physician. In this manner the early stages of these ailments may be detected and treated, thereby possibly averting *apoplexy* or "stroke." This last is due to a rupturing or breaking of a blood vessel in the brain. If a clot forms or presses against nerve centers, slight or extensive paralysis, or even death, may occur.

Low blood pressure is rarely an indication of any serious disease. It is occasionally found as a result of tuberculosis, defective thyroid-gland action, or a weak heart, but low pressure does not mean necessarily that a person has any of these conditions. If it is certain that he has no serious disease and is in good condition, there is usually no reason for concern. It is most likely a hereditary blessing which goes with a wiry, healthy, long-lived type of individual.

Stimulate circulation intelligently. Frequently it is advisable to increase circulation through all or certain parts of the body.[1] Such is the case after a person has fainted or been shocked or chilled. At such times the blood flow should be stimulated by one or more of the following methods: (1) exercise (as when a healthy person is cold from exposure); (2) massage; (3) mustard plasters; (4) stimulating ointments; or (5) heat. The use of heat and cold are so important in regulating circulation that they need further explanation.

Use heat and cold properly. Heat and cold cause definite reactions in the blood vessels by acting reflexly on the vasomotor nerves. Heat relaxes or dilates the vessels and "draws" more blood to a part, while cold constricts the vessels and keeps the blood out. Ordinarily all parts of your body should be about the same temperature. Sitting for some time with cold feet, or a cold draft blowing on one side of the body, may disturb the temperature balance and cause congestion of the mucous membranes of the nose and throat and make you more susceptible to colds.

In abnormal conditions, heat and cold may be used to regulate the circulation as desired. Hence, you may use a hot foot bath to draw more blood to the feet and thus relieve a headache caused by too much blood in the head due to a cold or certain other factors. You may also apply alternate hot and cold packs to any painful muscle or gland to stimulate the circulation and relieve pain; or an ice pack to a black eye or other bruised area to prevent swelling. Cold applications are useful to relieve a sore throat, high fever, or an inflamed appendix. The last is very important to remember: *Always apply an ice pack to relieve pain in the region of the appendix and call a physician.*

When any part of the body is frozen or "frostbitten," the blood vessels in the skin and deeper tissues contract and the circulation is nearly or altogether shut off. This is not like ordinary "cold feet" which is merely a surface condition. Sudden heating of cold, contracted blood vessels often results in a painful inflammatory swelling known as a "chilblain." Hence it is advisable to rub frostbitten areas very gently until the circulation is partly restored before applying warmth.

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[1] In cases of infection care must be taken *not* to spread the infection. It is never advisable to rub even a slight infection.

Summary. The blood delivers food and oxygen to all cells and receives waste materials from them by osmosis through its capillaries. Blood is pumped to the capillaries through arteries and returned to the heart through veins. Lymph flows away from cells through special lymph vessels which empty it back into the blood stream.

Vasomotor nerves regulate the flow by dilating the vessels leading to, and in, working organs and constricting those which supply inactive parts.

Health and vitality demand a constant blood flow through healthy, unobstructed vessels. The circulation can be kept healthy by good posture, proper exercise, correct clothing, temperate living, and the proper use of heat and cold.

ACTIVITIES

1. Self-check on your study of this problem. See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. Study of circulation in a tadpole's tail. Wrap the head and body of a live tadpole or small fish in wet cotton and place it on a slide with the tail exposed. Study under the low power of the microscope. If the tip of the tail is in the center of the field, you may change from low to high power easily. It is exciting to watch the corpuscles pulsating through the arterioles, taking their time in the capillaries, and speeding up again in the venules.

3. Reports. Write or give orally a report on one of the following topics:

a. William Harvey, discoverer of circulation. His interesting story may be found in any history of science or encyclopedia (see References in the Appendix).

b. How I can train my circulatory system to keep me in the "pink of condition."

c. Why good circulation demands good posture.

d. How to guard against hardening of the arteries and high blood pressure. Why is it said, "A man is as old as his arteries"?

e. Gangrene, its cause and treatment.

4. Key words. Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each:

arteries (and arterioles)
veins (and venules)
capillaries
vasomotor nerves (include vasoconstrictors and vasodilators)
aorta
vena cava
spleen
blood pressure
lymphatics
lymph nodes
varicose veins

Your Health Habits

Check yourself on the following habits. Do you —

a. Maintain good posture both while asleep and awake?

b. Avoid standing still for long periods of time?

c. Exercise daily enough to stimulate flow of blood and lymph?

d. Habitually avoid intemperate eating and drinking?

e. Work and play moderately, avoiding strain?

f. Hold your emotions in check?

g. Avoid undue and uneven chilling of your body?

SUGGESTED REFERENCES[1]

Cannon, Walter B., *Bodily Changes in Pain, Hunger, Fear, and Rage*,* D. Appleton-Century Co., New York, 1939, pp. 93–107.

Clendening, Logan, *Health Chats*, David McKay Co., Philadelphia, 1936, pp. 202–205.

Davis, M., "Blood Pressure, Why High?" *Good Housekeeping*, June, 1940.

Fisher, I., and Emerson, H., *How to Live*, Funk and Wagnalls, New York, 1938. (See "Blood Pressure" and "Arteriosclerosis" in index.)

Harding, T. S., "High Blood Pressure," *Scientific American*, October, 1939.

—— "How's Your Blood Pressure?" *Time*, March 3, 1941.

[1] Use also books in *General References* in the Appendix.

* For advanced pupils and teachers.

Problem 8. *How Does the Heart Keep the Blood Moving?*

> The mainspring of life is in the heart. — Henry Amiel

STUDY OUTLINE

A. The heart — a double pump
  1. Why don't the red and blue blood become mixed?
  2. What are "leaky" valves? Cause?
  3. Why doesn't your heart get tired?

B. The heartbeat mechanism
  1. How can a heart beat outside the body?
  2. Why can life sometimes be restored a short while after the heart stops beating?
  3. What makes the heartbeat so regular?

C. Variations in the speed of heartbeats
  1. What regulates the speed of the heartbeat?
  2. Explain the effect of each of the following upon the heart rate and tell whether it is good or bad for you: (a) sleep; (b) exercise; (c) fever; (d) emotions such as fear, anger, and excitement.

D. How to protect and strengthen your heart
  1. What are the facts concerning the effect of each of the following upon the heart: (a) very strenuous exercise; (b) strenuous living; (c) alcohol; (d) tobacco; (e) headache remedies and pain killers; (f) syphilis, rheumatic fever, infected tonsils and teeth, and other diseases; (g) lack of sleep?
  2. Is heart disease usually indicated by heartburn, occasional pains around the heart, and palpitations?
  3. How can normal young people strengthen their hearts?

IS A person dead when his heart ceases to beat? Usually, yes — but there are exceptions. Recently a jockey was thrown from his horse with such violence that his heart stopped. The doctor pronounced him dead but decided it would do no harm to inject a stimulant directly into his heart muscle. The jockey's heart began to beat, and the next day he was ready to ride again. What happened? Can all people be restored to life similarly? You can understand the answers to these and like questions only after you learn something about the heart, how it acts, and just what it has to do with being alive.

THE HEART — A DOUBLE PUMP

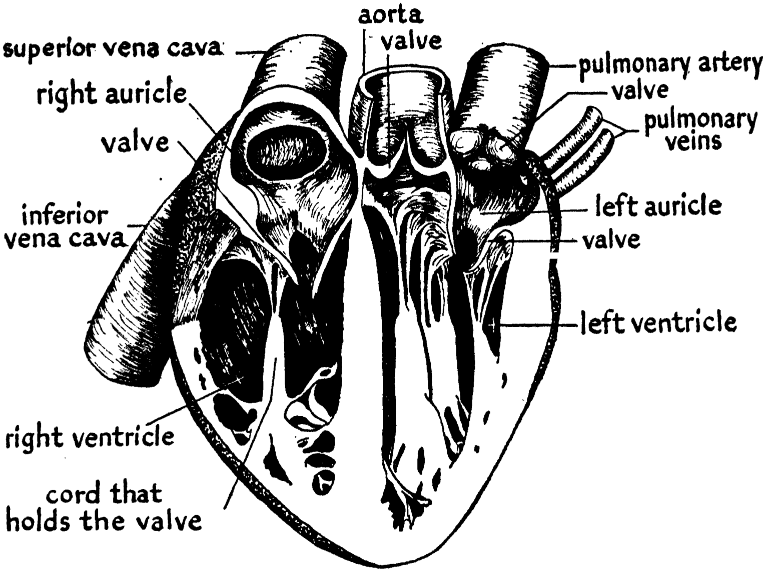
More marvelous and efficient than any mechanism man can make is a double pump called the heart. Did you ever stop to think how faithfully and regularly it beats every moment of your life? This is possible only because of its unique construction and "timing" device.

Protective shelter of the heart. Most people are surprised to learn where the heart really is located. It is a hollow, heavy-walled, muscular organ about the size of your fist located almost in the center of the chest between the lungs. You can feel its beat most easily a little to the left of the breastbone, between the fifth and sixth ribs. It is suspended there in a loose bag of delicate connective tissue. Between this bag and the outside of the heart is a small quantity of liquid which lessens the friction caused by the slight movement of the heart as it beats. Thus this all-important organ is protected by breastbone, ribs, and its own special coverings and fluid.

The heart's two circuits. Take a careful look at Fig. 36, page 123. Note that the blood circuit to the lungs is maintained by one half of the heart, and the circuit to the rest of the body by the other half. Both halves work at the same time, each one pumping a little blood into its own circuit.

If you can dissect a pig's heart, it will help you to understand how the two pumps work individually. Note that they are separated by a thick wall as shown in Fig. 41. The right pump receives dark blood *from the body* and sends it *to the lungs*. The left pump receives the red — oxygenated — blood *from the lungs* and sends it *to the body*.

The valves. A good pump must keep the liquid flowing forward and allow none of it to flow backward. To accomplish this the heart has four sets of valves, as you will see.



41 Cross section of the heart showing structure. Where does the blood go when it leaves each side of the heart?

Each side of the heart is composed of two chambers, the upper one called the *auricle* and the lower one, the *ventricle* (see Fig. 41). The auricles receive the blood from their respective veins. When the auricles are full, their walls contract and squeeze the blood into the ventricles. Then, an instant later, both ventricles contract and force the blood out into their respective arteries.

The blood is kept from flowing backward into the auricles by means of valves. These interesting little devices consist of irregular-shaped flaps of connective tissue which hang down into each ventricle and allow the blood to pass over them from above (see Fig. 41). When the ventricle contracts, however, and forces blood upward against the valves, the flaps open like little parachutes and blockade the entrance. Their outer edges are kept from going back too far by means of tough cords of white fibrous tissue from below. If you dissect a heart, note how very tough these cords are. Cut off only the lower tip of a heart and try forcing water through it from below. You will see how the valves close the passage into the auricle and send the liquid out into the arteries.

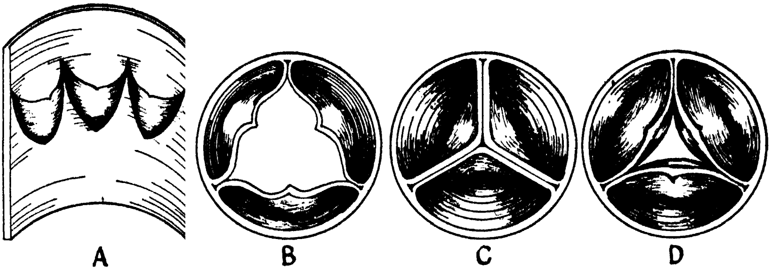
When once in the arteries, the blood must be kept from going back into the ventricles when these chambers relax. Therefore the opening from each ventricle into its artery is guarded by another set of valves (see Fig. 42). Each of these consists of three crescent-shaped flaps which flare out and fill the opening when the blood in the artery presses back on them.

In a strong, healthy heart there is no wasted energy. Every time the heart beats, each ventricle pushes about one half cupful of blood into its artery; this blood pushes against that already ahead of it in the circuit. Thus, if the valves are efficient, the whole stream is kept moving forward with no backward leakage.

Phases of the heartbeat. The average man's heart beats 72 times per minute. This gives about 0.8 second for one complete cycle or beat, which consists of two distinct phases. During the first half of each cycle all parts of the heart are at rest. The muscles are relaxed, the valves between the chambers are hanging open, and the whole heart is passive while it is being filled with blood. Suddenly there is a rapid succession of strong activity: the muscular walls of both auricles contract, followed an instant later by the contraction of both ventricles, and a spurt of blood is forced out into both main arteries. It is supposed that the snapping shut of the valves, first between auricles and ventricles and then those into the arteries, produces the sounds you hear if you listen to anyone's heart beat.

A leaky heart and its consequences. As you may have guessed, a leaky heart is one in which any of the valves do not close tightly but allow some blood to flow backward (Fig. 42D). Of course, this means that the forward motion of the stream is not as strong and forceful as it should be, nor is as much blood pumped out with each stroke. There is a loss of power, and the heart must work harder than normally to keep up the circulation.

Valve troubles may be caused by abnormal development or by disease bacteria which settle on the delicate valves and cause them to become inflamed. After an inflammation has subsided, it often leaves hard scar tissue which makes the edges of the flaps rough or causes the flaps themselves to become wrinkled and tough so that they cannot open properly; thus it is difficult for the blood to pass through. In other cases the valves may be shortened and fail to close the opening tightly, or the opening itself may have become too large for the valves to fill. A trained physician can tell from



42 Semilunar valve in the aorta. *A*. Note the pocket structure of the semilunar valve. *B*. The valve when open. *C*. The valve when closed. *D*. A "leaky" valve: imperfect closing after the edges have been damaged by illness.

the heart sounds which of these conditions exists and exactly which valves are affected.

When some of the blood leaks back through the valves, the heart has to work harder to repump this blood, and the added exercise gradually causes the affected side of the heart to become enlarged, just as any muscle enlarges with exercise. In severe cases, the heart has been known to become four times its normal size in order to pump with each beat the original amount of blood needed plus the amount that flows back through the leaky valves.

By this enlargement the heart compensates for its impairment and enables its owner to live to a reasonable old age, provided he does not subject his heart to undue strain. Of course, there are different degrees of heart impairment so that all heart patients do not have the same limitations. Persons with leaky hearts, however, usually have little reserve and must be careful to avoid exercise or excitement that might overtax them. Running for street cars or engaging in sudden violent effort is especially unwise. Since medical science can do nothing to remedy this condition, such persons should recognize their limitations and calmly resolve to live accordingly.

The working power of the heart. This most wonderful pump in the world does an astonishing piece of work. It pushes the body's 12.5 pounds of blood, or about 1½ gallons, through the body every minute. This amounts to more than 17 tons in 24 hours. Actual measurements show that in the lying position the heart of an average man does about the same amount of work in 24 hours that his leg muscles would do in climbing a mountain 1,300 feet high. During sustained exercise the heart works two or three times as hard as this; and for short spurts of maximum activity it can work at six times this rate, or about $\frac{1}{40}$ horsepower.

You wonder how so small an organ can perform so much work without any vacation for 70 or 80 or more years. The answer lies in the fact that its cells relax completely after each contraction and have the power to recover rapidly from their work. Another important factor is that the heart beats more slowly and gets more rest during sleep. For a healthy person leading a normal life, with proper rest and sleep, the heart really works only 8 hours out of 24, if we count the time of actual contraction. Hence a strong heart does not give out suddenly, and should be able to do its work well to a ripe old age if it is not abused or injured. It cannot be expected, of course, to withstand the strain of overstimulation and overexertion or the weakening effects of poisons and disease.

THE HEARTBEAT MECHANISM

Can you imagine a heart beating all by itself after being detached from the body? It doesn't seem possible, yet every heart has that ability if it is properly removed and its cells are kept alive by artificial circulation through the special vessels that nourish it. Other muscles require nerves to make them contract, but the heart will contract and relax with all of its nerves cut. Then what makes it beat so rhythmically? We shall have to look for a structure within the heart itself to find the secret of its unfailing regularity.

The heart's self-starter. As mentioned before, the heart will continue to beat even if entirely disconnected from the body. It has been found that this phenomenon is due to a group of cells forming a node and called the *pace maker.* This node is located at the top of the right auricle, where it starts the stimulus for each heartbeat. As shown in Fig. 43, it is connected by fibers to a similar group of cells between the two auricles; this group makes the auricles work together. The impulse then passes down the *bundle of His*[1] and stimulates the ventricles to contract when their turn comes.

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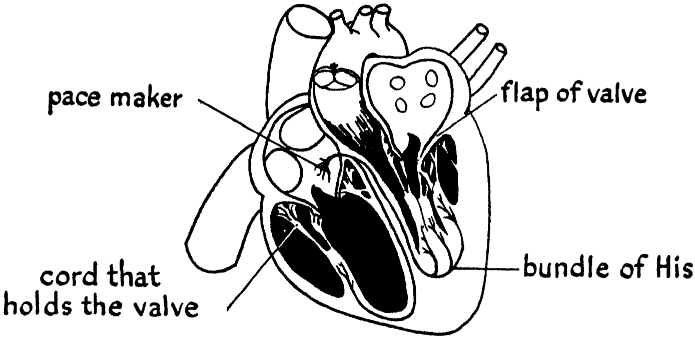
[1] Technically *His-Tawara.* A "bundle" of fibers named after His, a German, and Tawara, a Japanese, who did much research on this topic.



43 A section through the heart showing the location of the pace maker and the bundle of His.

Scientists have been forced to conclude that physical life depends, in the last analysis, upon the action of the pace maker. The heart stops beating when this node fails or when the heart is unable to respond to its stimulus. The latter is usually the case when a healthy heart is stopped by sudden shock, accident, or drowning; then there is a chance of reviving it. A person is not dead until the pace maker ceases to throb, which may be some time after the heart has stopped beating. For this reason artificial respiration is continued for as long as several hours before hope for recovery is given up.

Why all heart cells co-operate. Heart cells are linked together (Fig. 8J). All of the cells of any chamber communicate so closely with each other that if any one cell works, they all do. For this reason, every beat is a "wholehearted" one. If the heart beats feebly, it is because *all* of its cells are diseased, not because only part of them respond to the stimulus to act.

No heart cramps. You can get a cramp in your leg but not in your heart — thanks to its marvelous construction. The heart muscle will not start a second contraction without relaxing from the previous one. Very strong and rapid impulses may make it flutter but not cramp. The reason for this probably is that when the heart muscle contracts, it uses all its fuel resources for the time being and has to rest, at least to a certain extent, while it is "refueling." This fact also helps explain why the heartbeat is rhythmical and why half of each cycle is a rest period.

VARIATIONS IN THE SPEED OF THE HEARTBEAT

Your heart does not beat as fast as it would if the pace maker alone controlled it. Ordinarily it is held in check so that it has a reserve of speed to use when necessary. Hence it speeds up when you hurry for your next class, and it slows down when you lie down and relax. To help it to just meet your body's needs it has two sets of regulating nerves — one to slow it down and the other to speed it up.

Nerves of the heart. The heart is kept from racing by a set of *inhibitory* nerves. These are branches of a large nerve called the *vagus* (vā′gŭs), which originates at the base of the brain. Among all the nerves to the heart, one particular branch of the vagus has the greatest influence on the heart rate. When the vagus is cut, the heart "runs away," for this nerve acts like the reins on a fiery horse which keep it in check.

The nerves which speed up the heart in emergencies are called *accelerators*. They come to the heart from certain centers of the "sympathetic" [1] nerve chain, which lies close to the spinal column. These nerves are influenced by the impulses traveling through the spinal cord to and from all parts of the body. Hence many things can indirectly affect the accelerator nerves and speed up the heart, such as nerve impulses caused by excitement, fear, and anger.

Thus the inhibitory and the accelerator nerves balance each other and keep the heart beating at just the right speed so that it will supply blood as fast as the body needs it but will not waste its energy by doing more than is necessary. It is difficult to determine whether the heart is speeding up because the vagus has "taken off the brakes" or because the accelerator nerves are "stepping on the gas."

Normal rate of heartbeat. The rate of the heartbeat varies greatly among individuals. For some persons it is normally as low as 50 beats per minute and for others as high as 90. But the average is about 72. The rate also varies with age, being at birth about 140 beats per minute and gradually slowing down until in youth it reaches 85, and in adult life 72; in old age it varies between 70 and 80. These figures are for males in a sitting position. In general, the rate for females is about 5 beats per minute higher than that of males.

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[1] The name "sympathetic" was given to those nerves which act in unison — in "sympathy" — with other nerves.

Just as a small clock ticks faster than a large one, so a small heart generally beats faster than a large one. The probable reasons are that the smaller the body the faster the blood returns to the heart, and also the faster the cells use oxygen the faster the heart must beat to supply it. A hummingbird's heart beats about 1,200 times per minute, a mouse's heart about 680, a dog's 36–50, and an elephant's only 25–28.

Factors affecting your heart rate. When you are lying down, your heart does not have to pump blood against gravity. When you are sitting it beats about four beats per minute faster, and when standing, about 14 beats per minute faster. Do you now see why lack of rest is hard on the heart?

You are aware that exercise also increases the heart rate. You probably would not realize, however, that even light muscular work such as tapping a telegraph key may raise the heart rate from about 70 to 100 beats per minute, while moderate or heavy work may raise it as high as 150 to 180 per minute. After continued strenuous exercise such as a long swim or run it may require an hour or more for the heart rate to return to normal. This obedience of the heart to the needs of the muscles is one of the most important examples of co-operation between organs.

In cases of fever the doctor always feels the pulse because blood heat affects the heart rate immediately. Up to 103 degrees, the temperature of the blood acts directly upon the heart tissue (not its nerves) and gradually increases its rate. Above 103 degrees, increased temperature slows the heart until at about 107 degrees or above it stops it altogether. A low fever usually indicates that the body is eliminating poisons properly and putting up a good fight against invading germs; but when it runs too high, it becomes dangerous.

Subnormal temperatures lower the heart rate; and as the blood gets colder, the heart gradually slows down. When the blood reaches a temperature of about 64 degrees, a human being "freezes to death."

Certain chemicals in the blood affect the heartbeat in various ways, each one producing a definite effect. When absorbed by the blood, they are carried to all parts of the body, including the tiny endings of the nerves which inhibit and accelerate heart action. Some chemicals stimulate one set of nerves and some the other. Carbon dioxide, lactic acid, and adrenalin are *normal* stimulants, produced by the body itself, while alcohol, tobacco, and other drugs are foreign poisons whose specific effects will be discussed in the next section.

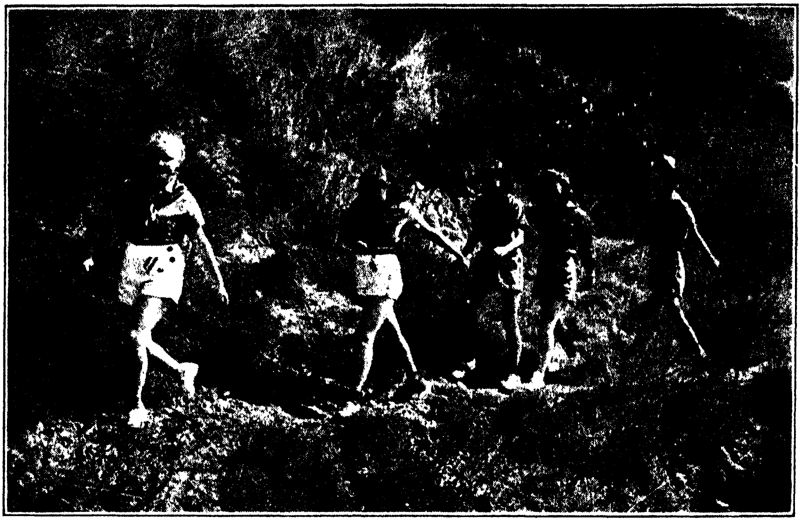
HOW TO PROTECT AND STRENGTHEN YOUR HEART

Among all causes of death, heart disease is the most frequent. If human beings lived naturally and healthfully in both mind and body, most hearts would do their work consistently through long lifetimes. But moderns have fallen into a great many modes of life which place a greater strain upon the human heart than it was ever fitted, biologically, to stand. Doctors and hygienists assert that most of the causes of heart disease could be prevented. Insurance companies are crying, "Give your heart a chance!"

Never before was it so important for each individual to know how to give his heart a chance and to govern his life accordingly. Within the limits of this book we can point out only a few of the most frequent abnormal factors which weaken the heart, and indicate the simple means by which they may be avoided.

Exercise properly. You cannot train the heart for emergencies by giving it sudden hard tasks to do. You must train it by regular exercise — beginning with a little, and gradually increasing the amount. In this way the heart muscle gains in strength until it can do with ease two or three times as much work as it did before. Athletes build up their skill and efficiency by this method.

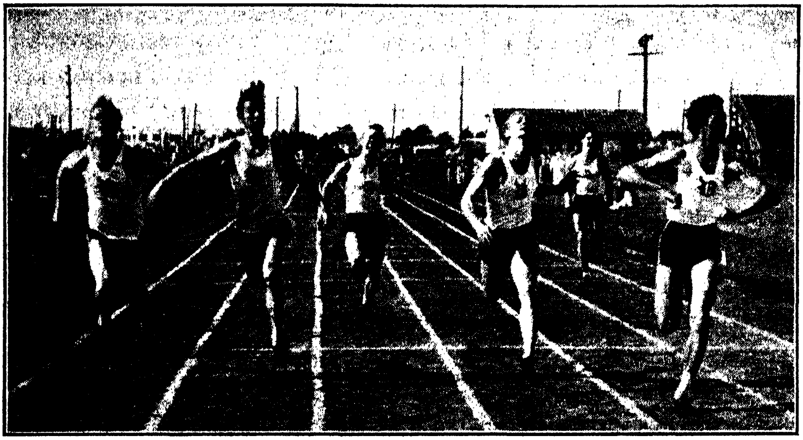
The physical let-down of most people after leaving school and in middle age is largely a matter of stopping practically all physical activity. If slight exercise causes such a person to gasp for breath and his heart to beat violently, he probably needs to "train up" to renew his strength. Many persons continue dancing, tennis, swimming, and similar sports, done moderately, long after 50 and are healthier for it. To get the most out of life keep the heart and other muscles toned up and ready for emergencies by regular exercise.



44 Outdoor exercise, not too strenuous, is the best method of strengthening a normal heart.

Avoid athletics that may strain the heart. Whether competitive sports are justifiable for high-school pupils is questionable. Between the ages of 13 and 16, the growth of skeletal muscles is far greater than the increase in power of the heart. Many boys and girls at this age become unusually tired from even normal activity. If they follow their own inclination, they will not overdo because of their feeling of fatigue; but under the stimulus of winning for the school and gaining some reward, they easily push themselves too far. Also, after an illness, even a severe cold, they may do their growing hearts an injury which can never be repaired. The best authorities agree, therefore, that high-school athletics should be very carefully supervised, that pupils should be rigorously limited in the kind and number of events in which they compete, and that they should be compelled to *train gradually* up to the peak of activity before being permitted to compete at all.

Enjoy noncompetitive sports. Don't avoid healthful games because you fear athletic heart. X-ray studies indicate that trained athletes, on the whole, have larger hearts than other men of the same age. It is not known, however, whether their hearts are larger because of their athletic training or whether they go in for



45 Competitive sports may be disastrous for young hearts. The boy in the center shows the strain of fatigue. His heart doubtless is registering the strain even more than his face, but his heart may not recover.

athletics because they already have naturally larger and more powerful hearts. At any rate, it has been shown that men who have participated in *college* athletics may expect to live just about as long as nonathletes. This is especially true when they make a point of "training down" before starting work in offices. The importance of such *gradual* preparation cannot be overemphasized.

Careful research shows that young people seldom injure their hearts in sports which they enter purely for recreation without the overstimulation of interschool competition. This type of activity is exhilarating because of the fun in it; it calls forth healthy emotions and trains for good sportsmanship. No normal young person should ever eliminate himself from sports or games which he enjoys and which do not make him overtired.

Live simply and control your emotions. Modern physicians agree that overstimulation of the emotions in many different ways is one of the reasons why heart disease is our leading cause of death. The continued excitement, competition, and rush of modern life are putting an unnatural burden upon the human nervous system and heart. Much of it can be avoided, and whatever cannot be avoided should be taken calmly and with self-control.

Avoid the use of alcohol, tobacco, and patent medicines. The sale of drugs of all kinds may be greatly reduced when intelligent young people learn their dangerous effects *before they get the habit of using them.* This would be a sad blow to many money-making manufacturers, but many persons believe it should result in a marked improvement in the health and morals of the people of our nation.

Alcohol is not a true heart stimulant, as many persons wrongly believe. However, moderate amounts of strong alcoholic beverages do increase the rate of the heart beat, although this is an indirect result. The alcohol irritates the throat and esophagus. This irritation, in turn, initiates nervous reflexes which increase the heart rate temporarily. It is this temporary effect on the heart which had led many persons to believe that alcohol stimulates heart action. This explains also the apparent stimulating effects of brandy or whiskey when given to one who is on the verge of fainting; the effect is the same as that of smelling salts and is caused in the same way. Alcohol is not a real heart stimulant and therefore not an appropriate remedy for fainting.

The excessive use of strong alcoholic beverages actually depresses the heart muscle. When an individual has taken enough alcohol in a beverage to increase the concentration in the blood to a level that produces extreme drunkenness, the force of the heart beat is weakened. The pulse becomes rapid, but the total effect is a depressed function. Normal heart function is restored when the patient has recovered from the intoxication.[1]

Tobacco temporarily increases the heartbeat because it partially paralyzes the vagus nerve that holds the heart in check. After one cigarette the increase is approximately 10 beats per minute for adult men. The result is the same for habitual smokers as for nonsmokers. This speeding up of the heart does not serve the purpose of meeting any bodily needs; consequently the heart expends its energy in doing extra work without accomplishing anything, and lessens its reserve power. Authorities agree that this is especially injurious to growing boys and girls.

The weakening effect of tobacco on the heart is one reason that athletic coaches prohibit its use. Skill and endurance require the co-operation of a heart that has all the reserve power possible and one that can respond quickly and consistently to the demand for hard work. A tobacco smoker can't be sure of having such a heart.

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[1] See *Alcohol Explored* by H. W. Haggard and E. M. Jellinek (Doubleday, Doran) pages 103–04.

Some *patent medicines*, such as sleeping powders, headache medicines, soothing syrups, and pain killers contain drugs which act as depressants. Records show cases in which just one dose of some patent medicines has affected an already damaged heart with fatal results. A person with a healthy heart should take any of these preparations no more than occasionally, and one with a weak heart should avoid them entirely unless prescribed by his physician. Do not trust the advertisements in daily papers or magazines, for many of them are misleading!

Avoid diseases. The groundwork for most heart disease is laid in childhood and youth, although it may occur at any age. The germs which most often cause leaky valves, and leave the heart weakened are those present in *rheumatic fever*, *tonsillitis*, *diphtheria*, *scarlet fever*, *pneumonia*, and *syphilis*. Most dangerous among these is rheumatic fever, whose cause is thought to be a germ which attacks the joints and makes them very painful. In children it may appear as "growing pains," which should never be disregarded. At the first symptoms, everything possible should be done to prevent serious heart injury. Diphtheria, scarlet fever, and many other diseases are now preventable (see Problem 23), and every means should be used to avoid them.

After any infection, the heart cells are temporarily weakened by the absorption of poisons from the blood; after an operation or a noninfectious illness, the heart is weakened by lack of bodily activity. Hence it is safe to say that *after any illness or after childbirth the heart should be given plenty of time to regain its strength by rest in bed.* After any fever, remain in bed at least one to three days after temperature is normal and then resume activities gradually. It is difficult to induce babies and children to do this, but mothers should make every effort to keep them as quiet as possible. The importance of a strong heart far outweighs any reasons for getting up too soon.

Do not worry unnecessarily about your heart. Many people with really sound hearts believe they have heart disease. The symptoms they frequently associate with serious heart impairments are usually traceable to minor disorders such as indigestion and gas in the stomach, or nervousness. These may cause pain near the heart, shortness of breath, dizziness, fainting, irregularity of the beat, and heartburn. This last is a burning sensation in the chest which has nothing to do with the heart but is due to a chemical disturbance in the stomach. The cure, of course, is to treat the digestive tract and not the heart.

You probably get nervous and are more apt to make mistakes when someone watches you closely. Your heart acts the same way; it may change pace or even skip beats if you start listening to it and worrying about it. The best rule is to live properly and then forget about your heart.

Conclusion. Your heart is an automatic double pump with certain structures within it which cause both halves to beat rhythmically. It rests between beats to refill with blood from the veins. Since it beats more slowly when you lie down, you need 8 to 9 hours of sleep nightly to give your heart the extra rest it needs. Since it is a muscle, you can strengthen it by graded and consistent exercise.

A majority of heart weaknesses are due to lack of proper care in childhood and youth. Therefore be especially cautious in regard to the following common causes of heart disease: (1) overstimulation of emotions, competitive athletics, strenuous living with insufficient rest; (2) alcohol, tobacco, and other drugs; and (3) infections which may reach the heart through the blood stream.

For its size the heart is the most powerful engine known. If it is kept strong, it has great reserve power and will perform its heavy duty throughout a long lifetime. Keep it strong by hygienic living and control of emotions.

ACTIVITIES

1. **Self-check on your study of this problem.** See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. **Dissection.** Dissect the heart of a beef, sheep, or hog to study its structure and to see how the valves work. Instructions for dissection can be found in any standard manual for physiology or biology. See References in the Appendix. *Note:* This may be deferred and performed in connection with Activity 2, page 187.

3. **Counting pulse.** Learn how to take the pulse correctly and determine your average heart rate while sitting (see page 127).

4. **Heart rate of girls and boys.** Get the average heart rate for all girls in the class, then boys. Compare. Note individual variations.

5. Heart rate versus age. Determine from your own experimental evidence whether the heart rate varies with age, by taking the pulse of each of several elderly persons, adults, youths, and children, all in a sitting posture. Average each age group separately and compare the results.

6. Heart rate and position. Find the variation in your heart rate when you are lying flat, sitting down, and standing up.

7. Heart rate and exercise. **a.** Have your laboratory partner take your pulse before and after some exercise such as running a short distance.

b. Find the length of time required for your heart rate to return to normal after some strenuous exercise.

8. Reports. Prepare a written or oral report on one of the following topics:

a. Heart disease, the one greatest cause of death in America.

b. The effect of athletic heart on athletes in training and in the business world.

c. How I plan to keep my heart strong and healthy.

d. The effect of alcohol, tobacco, and drugs on the heart. (Acetanilid is important to include.)

e. "A man's life may be saved by an attack of angina."

f. Hospital care for cardiacs. (See American Heart Association reports.)

g. The artificial heart invented by Dr. Carrell.

9. Key words. Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each:

auricles
ventricles
valves
leakage of the heart
enlarged heart
pace maker
inhibitory nerves
accelerator nerve
fatty heart

Your Health Habits

Check yourself on the following habits. Do you —

a. Have regular exercise, suited to *your* needs?
b. Avoid sudden strenuous exercise without training?
c. Avoid emotional upsets?
d. Avoid alcohol, tobacco, and patent medicines?
e. Always remain in bed at least 24 hours after a fever?
f. Have good care during illness?
g. Avoid worry, especially about your heart?

SUGGESTED REFERENCES [1]

"Artificial Heart," *Literary Digest*, April 23, 1939.

Bach, "False Alarms in Heart Disease," *Hygeia*, April, 1939.

Bishop, L. F., and Bennett, R. V., "Living with Heart Disease," *Hygeia*, September and October, 1941.

Boas, E. P., "How Restricted Is the Life of a Patient With Heart Disease?" *Hygeia*, September, 1938.

Crawford, J. Hamilton, "Public Health Aspects of Heart Disease," *Hygeia*, February, 1939.

Donaldson, A. N., "What Makes the Heart Go," *Hygeia*, December, 1938.

Donaldson, A. N., "Signs of Heart Trouble," *Hygeia*, 1939.

Levin, Louis, *Living Along with Heart Disease*, The Macmillan Company, New York, 1935. (This is probably the best single reference on this list.)

Master, Arthur M., "Optimism in Heart Disease," *Hygeia*, July, 1938.

White, Paul D., "Deadly Disease, Number One, Heart Disease," *Hygeia*, 1940.

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[1] Use also books in *General References* in the Appendix.

Unit IV. *Keeping the Blood in Good Condition*

HAVE you ever felt "below par" though you weren't really ill? Perhaps your head felt dull, or even ached, and you wondered what had happened to your usual enthusiasm. Did you ever stop to think that such a temporary slowing down *might* be due to a clogging of the machinery?

You cannot be keenly alive and efficient unless your blood stream is continuously being relieved of waste materials which are being poured into it by the body cells. At the same time it must receive an adequate supply of food materials for use by the cells. This unit deals with the delicate mechanisms which constantly remove from the blood its excess heat, wastes, and water and keep its fuel and oxygen content nearly constant. This servicing of the blood stream is accomplished by: (1) the heat regulating system — the skin and nerves; (2) the chemical regulators and purifiers — the liver and kidneys; and (3) the great gas exchangers — the lungs.

Problem 9. *How Is the Blood Kept at an Even Temperature?*

It's a bad sign when a man in a sweat shivers. — PLAUTUS

STUDY OUTLINE

A. Heating and cooling the body
   1. Why does cold weather "pep" you up?
   2. Does much meat in your diet really make you warmer?
   3. Explain the statements, "You shiver to get warm!" and "You perspire to cool off!"
   4. Is an athlete's temperature higher after a race?
   5. Does a cold shower really cool the body?
   6. What are the highest and lowest external temperatures human beings can stand? Why can they endure them?

B. Variations in body temperature
   1. How does your temperature ordinarily vary?
   2. How can you *feel* extra warm although your temperature is normal?
   3. By what means are heat production and heat loss regulated and balanced in the body?
   4. Is fever dangerous? What causes it? How can it be broken?

C. Proper ventilation for efficiency
   1. Why does poor ventilation make you inefficient?
   2. In your home, how can you maintain healthful air conditions?
   3. How should windows be adjusted to give proper ventilation?
   4. What is air conditioning?

YOU are a "warm-blooded" animal because your body has a most remarkable mechanism that keeps the blood at practically constant temperature regardless of surroundings. "Cold-blooded" animals, like frogs and snakes, do not have such a heat regulator; consequently their temperature varies from below 0° F. in winter to above 100° F. in summer. The difference lies in the fact that you possess an automatic control which governs the rate of producing internal heat and the rate of giving off heat from the body. It balances so delicately the amount of heat produced and lost that it keeps your normal temperature always the same, *i.e.*, 98.6° F.

The heating system. Buildings are often heated by circulating hot water through radiators. The water is heated by a control furnace. Your own heating system is comparable to this, for the blood absorbs heat from parts of the body and warms other parts as it circulates through them. Unlike a building, however, instead of having one large furnace the body has millions of tiny ones — the body cells. These microscopic "furnaces" produce enough heat to keep human beings warm in freezing temperatures — provided they have sufficient clothing to hold in the heat.

Heat is produced whenever food is oxidized or when other chemical changes take place in living cells. The muscles and the liver, wherein many chemical reactions occur, are the main sources of body heat and have a higher temperature than other internal parts. The skin and lungs lose heat by evaporation of moisture and hence have a lower temperature than the body as a whole.

Speeding up heat production. Since heat is produced by the burning of fuel in the cells, anything which increases the rate of burning, *i.e.*, the metabolic rate, will increase temperature. Hence your body is warmed mostly by: (1) *muscular exercise*, which, if vigorous enough, may temporarily raise the temperature 1 to 4 degrees or more — enough to prevent freezing; (2) *excitement*, which stimulates the adrenal and thyroid glands, and the secretions from these glands increase the metabolism of all cells; (3) *protein consumption*, especially in meat form, which increases metabolism;[1] (4) *low external temperature*, which stimulates adrenal glands and heat production;[2] and (5) *shivering*, which produces heat by causing the skeletal muscles to contract and relax slightly but very rapidly.[3]

By knowing these facts, you can aid your body in regulating its heat production, especially by the intelligent use and control of exercise, excitement, and protein intake.

The cooling system. Suppose you eat 3,000 calories of food daily. Your cells convert a large portion of this into heat energy. The blood absorbs this heat and must eliminate it as fast as it takes it on, or your temperature will either rise or fall. An athlete may produce heat so fast that his body's cooling system cannot keep pace with it. Consequently his temperature may rise as much as 3 or 4 degrees during an event; but soon afterward he loses this heat, and his temperature returns to normal.

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[1] How should this fact affect your diet in winter and summer?

[2] How does this fact explain why you need more food in winter? Also, explain why a healthy person feels a warm glow after a cold shower. Anyone who does not feel this glow should not take cold showers.

[3] Keeping in mind that every contraction of a muscle produces heat, explain why you sometimes shiver for a while, then stop, then shiver again.

Even when not exercising, your body eliminates heat constantly; otherwise your temperature would rise steadily. In fact, if your body were unable to radiate heat, it would be but a matter of minutes until death would overtake you. The use of gilt paint on the bodies of theatrical performers has prevented heat loss through the skin so as to cause death in several instances. Such showmen are now painted just before going on the stage and have the paint removed within 10 to 12 minutes.

The mechanism for cooling the blood depends on the several interesting processes discussed below.

Cooling by radiation. The skin loses heat by: (1) the radiation of heat directly from it, (2) the conduction of heat away from it by clothing and objects in contact with it, and (3) the warming of air next to it, which moves away, to be replaced by cooler air. These methods are responsible for about 70 per cent of the total heat loss from the skin. You lose less heat in these ways when the surrounding temperature is warm and when you wear more clothing. You also lose less heat if you have a heavy layer of fat underlying the skin. Fat so insulates the body from heat loss that individuals with much fat are better able to resist cold than thin persons. For the same reason they become more easily overheated and cool off more slowly.

Cooling by evaporation of moisture. Evaporation of water from the skin and lungs causes 20 to 25 per cent of the total heat loss from the body. You are familiar with the cooling effect produced when the body is wet and wind blows upon it. The chilliness is due to the fact that a great amount of heat energy is being taken from the body by the evaporation of moisture. The wind speeds up the evaporation so that the body must furnish heat faster. It requires about 250 calories (large) to evaporate a pint of water; thus, if a person's perspiration amounted to two pints of water per day and

46 Football teams guard their players well against chilling after a play. Are you equally careful to cool off gradually after perspiring?

if all of it evaporated, his body would rid itself of 500 calories ($\frac{1}{5}$ of his food intake) in this way alone.

Thus you perspire to cool off. Indeed, as much as 240° F. would not be too high to endure for a short time if (1) the air were perfectly dry, (2) you drank large quantities of water and perspired profusely, and (3) the evaporation of moisture were not hindered by clothing. Yet each summer we read of deaths due to excess heat even though the thermometer has not gone above 100° F. These deaths happen because of the condition of the air. If the air contains little or no moisture, perspiration evaporates quickly and the body is cooled fast. In *dry* climates, therefore, high temperatures are not oppressive. On the other hand, if the air is moist, perspiration remains on the body or drips off without any cooling effect. A temperature of 120° F. in a *damp* atmosphere causes body temperature to rise so rapidly that it cannot be endured for more than a few minutes.

Quite independent of perspiration secretion, some water also evaporates through the walls of the cells of the skin just as it does from an apple. It has been shown that persons born without sweat glands[1] lose considerable moisture in this way.

Cooling by breathing. When the air becomes warmer or your body produces more internal heat as during exercise, you automatically breathe faster and more deeply. This increases the vaporization of water from the lungs. Dogs depend on panting as their chief means of combating a rise in body temperature because they have practically no sweat glands except in their foot pads.

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[1] The nature of perspiration and the mechanism for its regulation are discussed in connection with the skin on page 242.

Internal aid to the cooling system. It is interesting to learn how marvelously the blood stream itself is regulated to aid in the cooling process. The body employs two methods for getting large quantities of heated water (blood) to the skin and lung surfaces to be cooled. First, when you are warm, the nerves send more blood to the skin by *dilating the skin capillaries.* When you are cold, the effect is reversed; the skin capillaries contract and blood is sent inward, thus holding the heat within the body.

Second, the body increases the amount of blood in the skin by adding more water to the blood. Hence, when your temperature rises, you actually have more blood in your vessels. The extra fluid comes from two sources. Part of it is blood previously stored in the spleen and large abdominal vessels, and now poured into the blood stream. Another part is water absorbed from the tissues. When the temperature is high, the tissues give this water up to the blood stream, and when cold they absorb it back again. The more water there is in the blood, the more heat it can carry to the surface to be cooled. Can you now explain why you should drink an extra amount of water in warm weather? What happens to the tissues if you do not drink enough water?

VARIATIONS IN BODY TEMPERATURE

Under normal conditions the cooling system is so nicely adjusted to act according to the heat produced that the body temperature remains at about 98.6° F. Of course, the temperature cannot be maintained exactly constant in all regions of the body nor in the same region at all times even under normal conditions. For instance, if you take your temperature by placing a thermometer in your armpit, you will find it to be about 1 degree less than in your mouth. This is because the skin is losing heat so fast it is cooler than the internal parts of the body.

Again, there are slight daily variations which are perfectly normal. Body temperature is usually highest in the late afternoon or early evening. It then falls during the night as much as 1 to

1.5° F., reaching its lowest point about 4 or 5 o'clock in the morning and then slowly rising again during the day. Infants, young children, and aged people have about 1 degree higher temperature than adults, and, on the average, women have a slightly higher temperature than men. Other normal variations depend on such factors as meals, exercise, hot or cold baths, clothing, season, and climate. Such variations cause worry only to misinformed people.

At times, however, the heat controls become seriously upset and the temperature becomes abnormally high or low.

Temperature sensations. The feeling of warmth or cold cannot be relied upon as a true gauge of the heat conditions within the body. Although a cool wind makes you feel cold, and summer sunshine makes you feel warm, a thermometer would show your temperature to be 98.6° F. in both cases. In malaria the condition of the skin is such that although the patient's temperature is high, he has chills and calls for more covering. Remember, "temperature" refers to the true internal condition, and not the external sensation of heat or cold.

The heat-regulating device. Fever and subnormal temperature seem to be caused by upsets in the central switchboard which controls the body's heating and cooling system. This heat-regulating center is similar in action to the action of a thermostat. It consists of certain nerve groups in the lower part of the brain. These nerves are apparently influenced in two ways: (1) by the *temperature of the blood* flowing around them, and (2) by *reflexes from the skin.*

The exact means by which the nerves maintain this balance is not fully understood, but it is known that in response to hot and cold stimuli from the blood and skin they turn the following mechanisms on or off as needed:

Heat-producing devices	Stimulate the muscles to act, become tense, or shiver.
	Stimulate metabolism.
Heat-losing devices	1. Stimulate nerves that regulate sweat glands.
	2. Stimulate breathing.
	3. Cause vasomotor nerves to redistribute blood.
	4. Regulate water content of the blood.

In a healthy person this heat-regulating center and the complicated mechanisms it controls should respond quickly to external changes in temperature. If they do not react normally, they can be trained to some extent by exercise which promotes sweating, and by cool showers for only a few moments, followed by brisk rubbing with a coarse towel.

In cases of abnormal temperatures this nerve center appears to be affected in such a way as to set the balance at a somewhat higher or lower level. Such disturbance may be due to blood infections, drug action, or prolonged exposure to heat or cold. When you have a cold, you are unduly sensitive to temperature changes, probably because of toxins in the blood which affect these nerves.

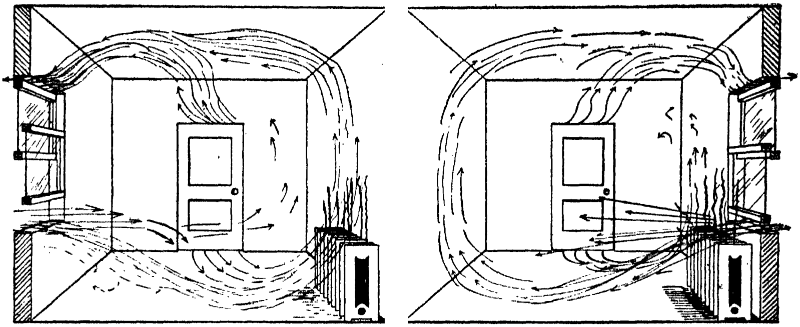
Subnormal temperature. It is much easier to raise the temperature of a normal person than to lower it. This is because the heat-producing mechanism of the muscles and other tissues is much more efficient than the cooling system of the skin. Hence fever is more common than subnormal temperature. An unduly low temperature may be caused by excessive loss of heat by hemorrhage or profuse sweating. It may be due also to lessened heat production, as after a long fast or illness. Life can be maintained for only a short time at a body temperature below 95° F.

Fever. A temperature above normal is often a warning of serious disease, but *unless of high degree*, it is not detrimental *in itself* (see Problem 8, page 142). Experiments with animals indicate that fever is an important aid to the body in combating disease, as the higher temperature kills many bacteria within the body. As a matter of fact, fever is induced by artificial means in the treatment of many diseases.

In addition to a higher temperature, a person with fever also shows faster heart action, more rapid respiration, increased metabolism, and abnormal secretion of perspiration and urine. Drugs such as aspirin, salicylates, and quinine lower the temperature in fever by stimulating heat elimination, chiefly through increased perspiration, though they may not in any way cure the condition which actually causes the fever.

PROPER VENTILATION FOR EFFICIENCY

Have you ever felt drowsy, depressed, or unable to think clearly, and then suddenly discovered that you were all right when you got


INCORRECT CORRECT

47 Room ventilation. The room shown at the left is incorrectly ventilated. Cold air currents coming in through the window travel along the floor and rise at the radiator after being warmed. They then travel along the ceiling and escape through the top of the window without having touched the center of the room. Can you explain why the room at the right is correctly ventilated?

out in the fresh air? You probably thought the difference was due to a greater amount of oxygen in the fresh air. The real reason, however, for your revived spirits was the effect of moving air upon your heat-regulating system. The former depressing effect was due mainly to the stagnation of heated, moist air next to your skin. The instant this layer of air was changed your heat-regulating mechanism was able to function effectively.

Employers are realizing more and more that no one can work efficiently if his heat-regulating system is being overtaxed. They have learned that it pays to air-condition factories and offices so that heat released from the body surface will be carried away quickly. To maintain such a condition is a problem of ventilation. If air is to have a cooling effect on the body and also be fit to breathe, it must have the following three characteristics: (1) a suitable *temperature*, (2) the proper amount of *moisture* (humidity), and (3) *movement*. Let us consider the practical means of assuring these conditions.

Maintaining the right temperature. Very cold air absorbs body heat too rapidly, thus chilling the body. Very warm air can absorb little or no heat and causes you to perspire too freely. Air of the right temperature, however, takes up heat as fast as the body throws it off. Experiments have shown this "happy medium" to be about 68 to 70° F.

The temperature should be as uniform as possible for all parts of the body. Floors are often 10 degrees colder than the air 6 feet above them (Fig. 47 *left*). A serious attempt should be made to regulate heaters, windows, and fans so that the temperature by artificial heat does not go above 70 or below 66° F., and so that floor and ceiling temperatures differ by not more than 3 degrees. "A thermometer in every home" is a good slogan.

Securing proper moisture. When the air contains a relatively large amount of moisture, evaporation cannot take place rapidly. You feel hot and sticky and complain of the air being "muggy" or "oppressive." Very little can be done for this situation except to keep the air fresh and in motion.

You are more likely, however, to suffer from the opposite condition — too dry air, especially indoors in winter. This is more serious because (1) it dries and irritates the lining of the nose and throat and makes you more susceptible to colds, and (2) it makes you feel the cold worse because it evaporates body moisture so rapidly. Dry air that feels 10 degrees too cold may be made comfortable *merely* by adding proper moisture without warming it at all.

It is extremely difficult to keep the air sufficiently moist in the average home in winter. Hence it is safest not to let the temperature rise above 65 to 70° F. because at such temperatures less moisture is required for healthful conditions. One of the best methods is to have ample window ventilation, for outdoor air usually is moist. The relative humidity (degree of moisture) should be about 40 to 50 per cent.

Keeping the air in motion. Stagnant air next to the skin soon becomes warm and moist and prevents further radiation of heat or evaporation of water. But air kept in circulation takes up heat better because more air comes in contact with the body. *The cooling power of air may be increased by keeping it moving even if it is hot and moist.* Changing air currents also helps to eliminate the disagreeableness of body odors.

In air-conditioning systems the temperature, relative humidity, and movement of air are all controlled by drawing outdoor air into a chamber, where it is cleaned, and heated or cooled to the desired temperature, and then circulated through the rooms by a system of fans. Window ventilation, however, *if intelligently regulated*, is

48 Proper clothing for every type of weather is important. Don't forget to remove warm outer clothing when you go indoors.

highly satisfactory and has some advantages over artificial systems. In opening windows keep in mind that heated air expands and rises to the ceiling, while the heavier, cold air sinks to the floor. If windows are open at both top and bottom, stale air will flow out above while fresh air will come in at the bottom, as shown in Fig. 47. In the very coldest weather windows may be opened only a little, because the great difference in the outside and inside temperatures will cause sufficient change of air.

Avoid sudden changes in temperature and strong drafts, not because there is any harm in a draft, but because if you happen to be perspiring, the draft may cause your body to cool off too rapidly, producing congestion in some of the capillaries and lowering your resistance to colds.

Relation of clothing to skin ventilation. The rate at which the body cools depends largely upon how rapidly the layer of air next to the skin is renewed. Clothing regulates this rate and also prevents heat loss by radiation. Loose and porous garments permit the air to be changed, though not too rapidly. All underclothing should be of this type. Knitted cotton goods fulfill these requirements better than closely woven goods. Smoothly woven cotton easily becomes saturated with perspiration and then forms practically a sheet of water over the body. This retards further evaporation from the skin and increases the danger of chilling from a draft.

Outer clothing should be varied according to the atmosphere. Linen conducts heat away from the body best and makes the coolest clothes. Wool and fur are poor conductors of heat and therefore retain body heat. Cotton and silk are most satisfactory for moderate temperatures.

Conclusion. Since heat production is due to the burning of fuel in the cells, you increase it when you exercise, become excited, become cold, shiver, or eat proteins.

Your temperature is kept nearly constant by the heat-regulating center in the brain. The chief mechanism it uses for cooling the body is perspiration. Keep all the heat-regulating devices responsive by exercise that causes perspiration and by brisk cold showers. Avoid cold showers if you do not react well to them.

For bodily comfort and efficiency regulate ventilation and clothing so that the layer of air next to your skin will (1) be the right temperature, (2) have a correct amount of moisture, more in winter and less in summer, and (3) be changed constantly, slowly if the air is cold, and faster if the air is warm.

ACTIVITIES

1. Self-check on your study of this problem. See now if you can answer all the questions in the study of this outline. Discuss them in class.

2. Observation of temperature. With a clinical thermometer measure and record your own temperature under the following circumstances: (**a**) Compare when taken by mouth and under your armpit; (**b**) compare records for morning, noon, and night; (**c**) take it just before, immediately after, and one half hour after some hard exercise that makes you perspire freely. Explain the results.

3. Checking ventilation at home. Diagram several rooms of your home, showing how they are heated and ventilated. Trace the probable air currents. If you find any faults with the system, remedy them in the rooms as well as you can. On a second diagram show what you did.

4. Checking school ventilation. Form a committee to record the temperature of every room in your school during the same period for a week. If you find great variations, submit your records to your school health committee.

5. Key words. Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each:

evaporation
shivering
perspiration (purpose, etc.)
heat-regulating system
subnormal temperature
fever

Your Health Habits

Check yourself on the following habits. Do you —

a. Regulate your diet according to the weather?
b. Drink extra quantities of water in warm weather?
c. Exercise daily enough to perspire?
d. Avoid sudden cooling when sweaty?
e. Always wear loose, porous underclothing?
f. Regulate your outer clothing according to the weather?
g. Avoid wearing overcoat, heavy sweater, or rubbers indoors?
h. Always work, play, and sleep in well-ventilated places?

SUGGESTED REFERENCES [1]

"Air Conditioning and Clothing," *Science Digest*, December, 1940.

Best, C. H., and Taylor, N. B., *The Human Body and Its Functions*, Henry Holt, New York, 1932, pp. 193–195.

Clark, M., "Fighting Disease With Heat and Cold," *American Mercury*, June, 1941.

Clendening, Logan, *Common Sense Health Chats*, Blue Ribbon Books, New York, 1939. (Use index.)

Diehl, H. S., *Healthful Living*, McGraw-Hill Book Co., Inc., New York, New rev. ed., 1941. (Use index.)

"Hot Weather Health," *Hygeia*, July, 1940.

Slosson, Edwin E., *Chats on Science*, The Century Co., New York, 1924, pp. 106, 114.

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[1] Use also books in *General References* in the Appendix.

Problem 10. *How do the Liver and Kidneys Regulate Certain Blood Materials?*

> Polluted streams again are pure,
> And deepest wounds admit a cure.
>
> — EDWARD MOORE

STUDY OUTLINE

A. The liver — the chief blood conditioner
  1. Why could a person not live with his liver removed?
  2. "The body's storehouse" — why is this term applied to the liver?
  3. "The body's chemical center" — why is this term applied to the liver?
  4. How is bile manufactured?
  5. "Hobnail liver" — what is it? What is its principal cause? Can it be cured?
  6. Why does jaundice make a person's skin turn yellow?

B. The kidneys — filters for the blood stream
  1. How do the kidneys remove wastes from the blood?
  2. Why does the blood always contain about the same amounts of water and useful salts?
  3. How could you injure your health by habitually not emptying the bladder often enough?
  4. How can two small kidneys purify all the blood in the body?
  5. How can you speed up kidney action to cleanse the blood as rapidly as possible?
  6. Why do doctors so commonly require a urine analysis? What may they learn from it?
  7. Explain why the kidneys are overworked by drinking too little instead of too much water.

IS YOUR blood stream clean? If it is, you owe thanks to your hardworking *liver* and *kidneys.* If these stopped working completely for an hour, yes, even a few minutes, the accumulated wastes in your blood would bring about such self-poisoning as to be noticeable throughout your entire body. At first you would experience merely "peplessness" and a headache and then more severe symptoms such as nausea, and after a few hours convulsions and death.

Fortunately for you, the liver and kidneys can stand a great deal of abuse — and most people give them plenty of it. Since they are so vitally important to your efficiency, however, you owe it to yourself to learn something about them and how to keep them in the best of condition.

THE LIVER — THE CHIEF BLOOD CONDITIONER

You *could* live without your stomach, or one lung, or one kidney, but not without your liver. It performs a larger variety of functions than any other organ. It has been called the "chemical center" of the body because it works over every drop of blood, removing some chemicals from it, changing some, and pouring others into it. These blood-conditioning duties make it one of the busiest organs in your body.

What the liver does. The following is but a partial list of duties performed by the busy liver:

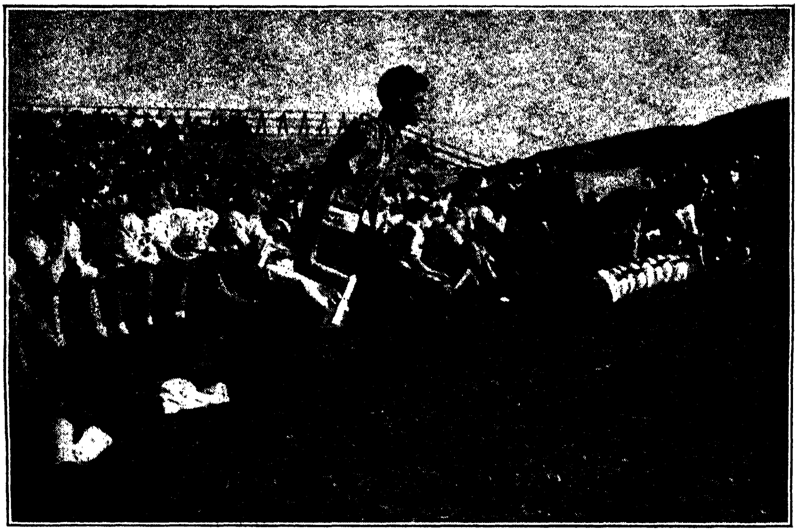
1. It is the body's storehouse for sugar. It converts the single sugars from the digestive system into a more stable form called *glycogen* (glī′kō-jĕn). This it stores within its own cells. Later it reconverts the glycogen into *sugar* (glucose) and sets it free in the blood stream as fast as the body cells need fuel.

2. It strains from the blood the excess proteins (amino acids) that are not needed by cells for building and those that are of the wrong type, and also the protein wastes from all cell destruction in the body. From these it forms *urea* (ū′rē-*ȧ*) which it pours into the blood a little at a time to be eliminated by the kidneys.

3. It removes the outworn red blood cells (probably already destroyed by the spleen) and uses these as part of the material for manufacturing bile.

4. It makes and secretes into the small intestine bile which aids in the digestion of fats and helps maintain healthful conditions in the colon.

5. It contains (and probably secretes into the blood) a substance necessary for the development of red blood corpuscles, and without which you would become anemic.



49 The little things in life add much to the success of the big things. How is drinking water, for instance, related to your own efficiency? Why can your liver and kidneys do their work more easily if blood chemicals are dilute? (See text.)

6. It forms fibrinogen needed in the process of blood clotting.

7. It destroys bacteria and poisons absorbed into the blood from any part of the body. These poisons it changes or stores or sends out in small quantities to be eliminated with the bile or with the urine.

8. It works over digested fats, though this function is not well understood.

Thus the liver performs three types of functions more or less bound up together: (1) storing materials; (2) straining out and excreting wastes from the blood; and (3) manufacturing or secreting substances.

How the blood is exposed to the liver cells. The liver (Fig. 23) is the largest solid organ of the body. It is located on the right side just under the diaphragm and inside the lowest rib. It overhangs the stomach and extends from the front to the back of the abdominal cavity. Its unique structure makes the liver an efficient detective for scrutinizing every drop of blood in the body.

On examining a piece of liver, you will note that its surface is smooth and mottled. A microscope shows that the little sections, called *lobules*, extend throughout the liver and form a most efficient organization of its busy cells. The lobules are packed closely together. Within each lobule two sets of tiny vessels are meshed together, carrying liquids in opposite directions. One set carries blood that is being worked on by the liver cells; the other set carries the bile manufactured by the cells. After leaving the lobule, the blood returns to the heart while the bile flows into the gall bladder and thence into the small intestine.

How bile is formed. Although the bile of all mammals is manufactured in the same way, it varies in color from green to reddish orange. This is due to the fact that it contains two pigments: one reddish in color, and the other greenish. Human bile has more of the reddish pigment and therefore has a yellow or orange cast. Both of these pigments are derived from the hemoglobin of the worn-out red cells. The liver adds the pigment to the bile salts, so important in the digestion of fats, and secretes the mixture as bile.

How jaundice affects the body. Bile sometimes enters the blood stream because it cannot pass properly through the bile duct into the small intestine (see page 93). This condition is called *jaundice.* A stoppage of the bile duct may be caused by (1) inflammation which has spread to the gall bladder and its duct from the near-by stomach because of the irritation of undigested food there, (2) congestion caused by bacteria carried in the blood, or (3) the passage of a large gallstone into the main duct. Such a stoppage may become serious because the whole body suffers when any waste accumulates in the blood instead of being eliminated.

The symptoms of jaundice vary in severity according to the amount of bile absorbed into the blood, from a mild yellow color of the whites of the eyes[1] to a slowing of the heart, severe headaches, anemia, and extreme nervousness. Obviously these symptoms might result also from other causes. The diagnosis and care of this trouble therefore require the skill of a physician. If the cause of the trouble is a gallstone in the bile duct, a surgeon may be required to remove the stone.[2]

How to make work easier for your liver. Knowing all the things your liver does for you, it would seem wise not to add to its many labors. Yet modern life is apt to be hard on the liver, and it is easy to abuse this patient organ without being aware of it.

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[1] This is due to the bile in the blood.

[2] Gallstones are an accumulation of bile salts which become crystallized about a collection of bacteria or mucus in the gall bladder. These stones are usually quite soft and, if small, may pass out without being felt.

To give your liver a fair chance avoid the habit of overloading your digestive system. Too much fat or rich food overstimulates the liver's bile-secreting function; too much protein causes it to overwork in producing urea; and too much carbohydrate overtaxes its capacity for forming and storing glycogen, and interferes with its work of manufacturing bile, fibrinogen, and hemoglobin. It is safest to eat a well-balanced diet in just the quantities your body can use.

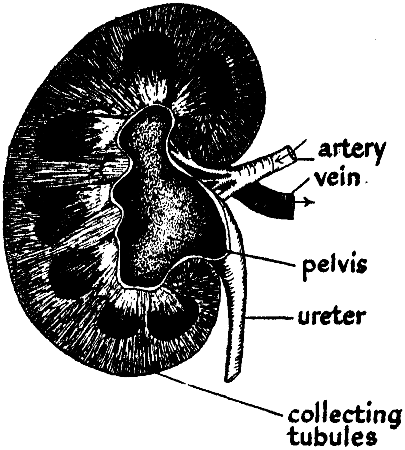
Exercise and deep breathing are also most important aids to the liver. The blood is kept moving through its fine network of capillaries by the action of the diaphragm. When you inhale, the diaphragm presses down on the liver and squeezes the blood out of it. When you exhale, the pressure is released and the liver capillaries become filled again. Hence poor posture and sedentary habits are among the liver's worst enemies.

Avoid the liver's arch enemy — alcohol. In time, heavy drinking produces an incurable scarring effect called *cirrhosis* (sĭ-rō′sĭs), or "hobnail" liver, which permanently disables the liver cells. In some cases even moderate drinking for a few years has produced cirrhosis. Alcohol is not the only cause of cirrhosis but it is by far the commonest one. No one uses alcohol habitually without being almost certain of decreasing the efficiency of his liver.

THE KIDNEYS — FILTERS FOR THE BLOOD STREAM

The kidneys are two large glands which do three vitally important things to your blood: (1) they rid it of 40 to 60 per cent of its excess *water*, but they retain water when the supply is low; (2) they strain out poisonous wastes prepared for them by the liver [urea, uric acid, creatinine (krē-ăt′ĭ-nĭn), and creatin (krē′ȧ-tĭn)]; and (3) they regulate the concentration of certain salts, such as sodium chloride and ammonia, by removing the excess amounts. This last function helps preserve the acid-alkaline balance of the blood and also helps maintain the right conditions of body fluids for osmosis. The health, and even the life of the body, depend upon how well the kidneys perform these apparently simple functions.

The urinary system. Although the kidneys do the actual work of cleansing the blood of water and dissolved wastes, the entire *urinary system* is necessary to excrete the urine out of the body. This system of organs (Fig. 11) consists of the *two kidneys*, two tubes called *ureters* (ū-rē′tẽrs) which carry the liquid from the kidneys into a storage reservoir called the *bladder*, and a short canal, the *urethra* (ū-rē′thrȧ), which leads from the bladder to the exterior of the body.



50 Lengthwise section of a kidney to show its general structure. The little tubes opening into the pelvis cannot be seen without a magnifying lens. After urine is secreted into the pelvis, where does it go? See Fig. 11, page 34.

The kidneys secrete urine constantly, drop by drop, into the bladder, whose own outlet is guarded by a circular muscle which holds the fluid until the muscle is released, normally as an act of will. As the bladder fills up, its muscular walls relax their tone and permit it to expand. Then, to empty it the circular guard muscle is relaxed and the muscles of the bladder walls contract until the walls are flat together. These muscles may be so completely under the control of the will as to endanger health if the signal for emptying the bladder is not heeded within a reasonable length of time. If the urine is held in it too long, poisonous wastes are reabsorbed into the blood.

How the kidneys work. It is estimated that the kidneys expose the blood to 70 square feet of cell area or the floor area of a small room! This is accomplished by conducting the blood through a vast number of tiny *tubules* compressed into two kidneys each about the size of your fist.

The kidneys are located on either side of the spinal column just inside the lowest ribs. Each kidney is bean-shaped with its hollow side toward the spinal column.[1] Note in Fig. 50 that the center part of the kidney is a cone-shaped cavity called the *pelvis*, which opens into the ureter. The fluid is excreted into the pelvis by several million tiny structures called *glomeruli* (glŏ-mĕr′ōō-lī) arranged about it in the outer part of the kidney. As you will note in Fig. 51, each glomerulus consists of a ball-shaped structure from which a tiny twisted tubule extends into the pelvis. The tuft part is really a coiled capillary surrounded by a two-layered membrane, or capsule.

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[1] Follow the diagrams carefully in reading this and the next two paragraphs.

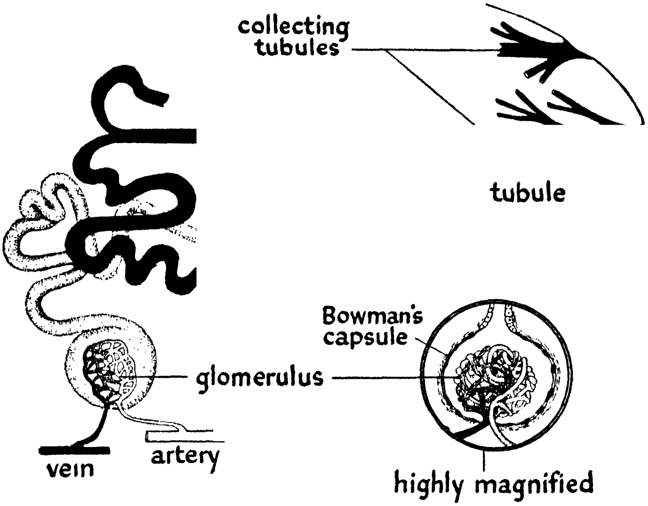
The water with its dissolved salts and wastes from the blood filters through the first layer of the capsule into the narrow space between the two membranes, and thence into the small coiled tubule which carries it into the pelvis. If the membranes are healthy, they do not allow the blood corpuscles or the large protein molecules to pass out of the capillary into the capsule. Thus the capsule acts as a true filter.

All the glomeruli together filter many gallons of liquid (20 or more) each day. Yet only a few pints pass out of the kidneys as urine. This is because the cells that form the walls of the tubule reabsorb and put back into the blood much of the water and the useful sugar, calcium, sodium, potassium, and amino acids. These cells do not absorb the poisonous wastes. Hence the kidneys are *selective filters*, for they eliminate the wastes and *excess* water and salts but conserve the materials the body needs. They regulate the composition of the blood so well that, in health, the proportion of salts, sugar, and water in the blood remains fairly constant.

How blood is exposed to cleansing by kidneys. All the blood of the body goes through the kidneys every few minutes. Note in Fig. 36 that some blood is shunted off from the aorta by an artery to each kidney, and that blood leaves the kidney by a vein which leads directly into the vena cava. Within the kidney the blood is slowed down to a rate of only 18 inches per hour in each tiny capillary within a glomerulus. Because any drop of blood has to go around only one glomerulus, and there are so many millions of these, they all together manage to get the blood through the kidneys in good time.

Variations in the amount of urine. Although the quantity of urine varies according to the amount of water a person drinks and the amount he perspires, the daily average for healthy adults is 5 to 6½ pints. Anything that increases the circulation of blood through the kidneys will increase the rate at which they secrete urine.

The formation of urine commonly is increased by: (1) Exercise, which increases the rate of circulation throughout the entire body;[1] (2) chilling the skin,[2] which sends more blood to the interior of the body; (3) the drug digitalis, which stimulates circulation; and (4) tea and coffee, which dilate the blood vessels within the kidneys themselves.



51 Diagram of minute structures where the kidney's work is done. Where does the glomerulus get the materials which it secretes as urine?

The nature of kidney disorders. Knowing as much as you now do about the body, you would expect that poisons in the blood stream would weaken the delicate capillaries and tubules of the kidneys. Such is the case, the commonest kidney poisoners being alcohol, salts of mercury, and toxins from infected teeth, tonsils, gall bladder, or infectious diseases such as diphtheria and scarlet fever. Hardening of the arteries also affects the kidneys.

All of the several types of kidney disease are serious but may be checked *if treated early.* In their first stages they may be detected easily by a urine analysis. Such an analysis is the *only* means of detecting them.

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[1] If it also increases perspiration, it decreases the amount of urine.

[2] Very small children who have difficulty in controlling urination are often helped by being kept warm, thus decreasing the amount of urine formed.

What a urine analysis may reveal. From what has just been said, the value of a periodic urine analysis in preventing serious kidney trouble is evident. Since the urine contains the end products of metabolism of all the body cells, a study of it also reveals to a physician many other conditions existing in the body. Moreover, the work of all the digestive organs and the spleen and liver have such an immediate effect upon the contents of the blood and urine that a urine analysis indicates directly how these organs are functioning. *Diabetes mellitus* (dī′ȧ-bē′tēz mĕ-lī′tŭs), a disease due to insufficiency of the pancreas, is but one of many ailments detected by this means.

Without expert chemical and microscopic analysis of the urine little can be learned from a person's feelings or from superficial examination of the urine. Not often does a diseased kidney cause backache, though advertisements would have you believe so. The color of the urine also tells nothing, as it varies naturally because it is related to the bile and sometimes to certain foods eaten. Patent-medicine manufacturers sometimes put dye in their remedies to color the urine and make the user believe the medicine has been effective. A sediment also is usually meaningless, as this develops upon standing and may be merely the ammonium carbonate that gives the urine its color. Pus or blood in the urine, however, may indicate a serious condition. The presence of either demands the immediate attention of a skillful physician.

How to keep the kidneys healthy. The kidneys seem to be injured not by the quantity of water they have to eliminate but by a high concentration of wastes in only a little water. *The drinking of quantities of water keeps the wastes well diluted and is imperative for maintaining the health of the kidneys.* Six to eight glasses a day is advised as a minimum for a healthy adult. Much more should be taken when one has a fever, a cold, or other disease in which the kidneys have to eliminate an unusual amount of wastes and toxins. It is particularly important to remember the water requirement when caring for children or patients too ill to ask for water or to realize their need for it.

Aside from drinking sufficient water you need do little for your kidneys except to *avoid* the causes of kidney troubles listed on page 171, and to have a urine analysis yearly.

No reliance should be placed in the numerous widely advertised patent "kidney remedies" and "cures." These worthless frauds are doubly expensive, for they give the sufferer nothing for his money and also delay diagnosis and treatment by an expert physician, who alone would be able to restore health.

Conclusion. Since a clean blood stream is absolutely essential to health and efficiency, the liver and kidneys should be kept healthy and active. The liver regulates the chemicals in the blood and prepares certain waste products so that the kidneys can eliminate them. Hence clean blood requires that both of these organs be kept healthy. This may best be done by daily exercise, habitual good posture, proper breathing habits, a properly balanced diet, sufficient drinking water, the avoidance of alcohol, and sufficient rest and sleep. Since all kidney diseases require *early* treatment, it is a good precaution to have a urine analysis every year.

ACTIVITIES

1. Self-check on your study of this problem. See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. Dissecting beef liver. Ask your meat clerk to show you a whole beef liver. Ask him approximately how much it weighs. Buy a half-pound piece cut from the edge of it (not sliced). In the laboratory observe the mottled markings of the outer skin of the liver. What are these? From the inside of the piece, can you find where any blood vessels run through it? With a razor blade cut a very thin section across a blood vessel and another section parallel to it. Examine these carefully under the microscope. How are the cells arranged?

3. Dissecting a lamb's kidney. Before cutting it, note its shape, size, and outer covering. Can you find where the blood enters and leaves it and where the urine leaves it? With a very sharp dissecting knife cut it lengthwise, dividing it like the two halves of a bean. With a reading glass note its general structure. Cut thin slices and observe under the microscope. Also examine prepared slides of kidney tissue. Describe and explain what you see. Do you think it took much work or care first to discover and explain kidney action as it has been discussed in the text?

4. Key words. Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each:

lobule
cirrhosis of the liver
jaundice
urine
glomerulus
selective filter
nephritis

Your Health Habits

Check yourself on the following habits. Do you —

a. Exercise daily enough to stimulate internal circulation?
b. Maintain good posture?
c. Avoid overeating, especially of rich foods?
d. Avoid alcoholic beverages?
e. Drink plenty of water?
f. Avoid chilling?
g. Have a urine analysis every year?

SUGGESTED REFERENCES [1]

Barker, M. H., "Deadly Disease Number 4: Inflammation of the Kidneys," *Hygeia*, May, 1940.

"Cirrhosis Without Drink: Liver Ills Produced in Tests Employing Improper Diet," *Newsweek*, March 18, 1940.

Cobb, W. F., *Health for Body and Mind*, D. Appleton-Century Co., New York, 1941. (Use index.)

Cockefair, E. A., and Cockefair, A. M., *Health and Achievement*, Ginn and Company, New York, 1936. (Use index.)

Haworth, A. J., "Managing Your Liver," *Health*, February, 1940.

Lameron, Dr. Erwin A., "Kidney Disease," *Hygeia*, December, 1936.

Williams, J. F., *Healthful Living*, The Macmillan Company, New York, 1938, pp. 100–101, 242–251.

[1] Use also books in *General References* in the Appendix.

Problem 11. *How Do the Lungs Supply Oxygen and Remove Carbon Dioxide from Blood?*

> And the clean air shines and twinkles as the world goes
> wheeling through;
> And my heart springs up anew
> Bright and confident and true. — STEVENSON

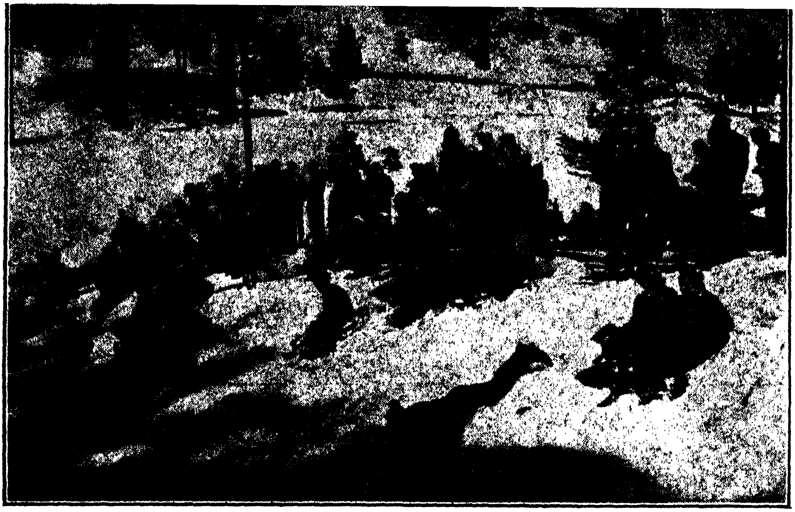
STUDY OUTLINE

A. The breathing machinery
  1. Why does mouth breathing irritate the throat while nose breathing does not?
  2. What is the larynx and how can it produce sounds?
  3. What keeps the windpipe from collapsing?
  4. If you ever had bronchitis, where are the tubes that were affected?
  5. What is pleurisy?
  6. What peculiar construction of lung tissue makes it so light?

B. Maintaining the breath of life
  1. How does the air you exhale differ from that you inhale?
  2. Explain and demonstrate how to breathe correctly.
  3. Can you increase your lung capacity? If so, how?
  4. Why can't you hold your breath until you become unconscious?
  5. Why do you breathe faster at some times than at others?

C. Avoiding obstructions of air passages
  1. Is removal of the tonsils ever necessary or is it just a fad?
  2. What undesirable conditions do adenoids produce?
  3. What are the causes and treatment for catarrh and sinus trouble?

HAVE you ever tried a brisk walk in the fresh air to revive dulled spirits or pull yourself out of the "blues"? It works like a charm. There is a scientific reason for it, too. The fundamental basis for this effect is that "pep" depends upon a continual release of energy by oxidation. When you walk briskly, you automatically take in



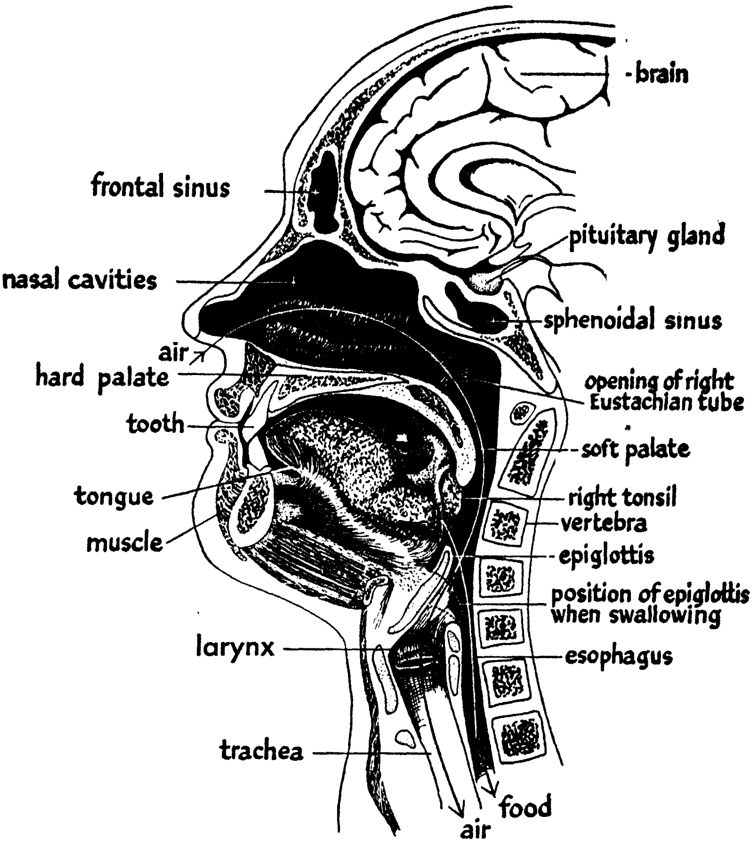
52 To promote energy, get an abundance of fresh air and exercise. These young people may return home fatigued, but the fatigue will be temporary; their bodies will be stimulated, and their minds refreshed.

more oxygen and also speed up the circulation which delivers oxygen and fuel to the cells. The result is that the whole body is refreshed and vitalized.

Those who are wise utilize this same principle to give themselves more energy *all* the time by constantly getting a plentiful supply of oxygen. This requires two things: (1) good air to breathe, and (2) correct breathing habits. Supplying the air is a problem of ventilation which you have already studied in Problem 9. Equally important, however, are your personal breathing habits, for poor posture and shallow breathing may produce undue fatigue in the best ventilated room. It may pay you large dividends in increased vitality to learn how your breathing apparatus (*respiratory system*) is built and operated and how to care for it.

THE BREATHING APPARATUS

The breathing apparatus is very simple. Each part is constructed to perform a definite function. If used properly, the entire system has certain natural protections, as you will see in the following paragraphs.



53 Sagittal section of the head. The pharynx is a cavity represented by the darkened portion immediately below the sphenoidal sinus down to the epiglottis.

The entrance — the nose. Note in Fig. 53 that the lower part of each nostril is a fairly large channel through which air passes into the throat. Above this is an expansion of air spaces formed by irregularly shaped bones and cartilage, the principal ones being the three *turbinate* bones.

The covering of the two uppermost bones and of the partition between the nostrils contains the cells for smelling. Since this small area, called the *olfactory region*, is above the main air passage, smelling is aided by sniffing so that air will go up into these tiny pockets.

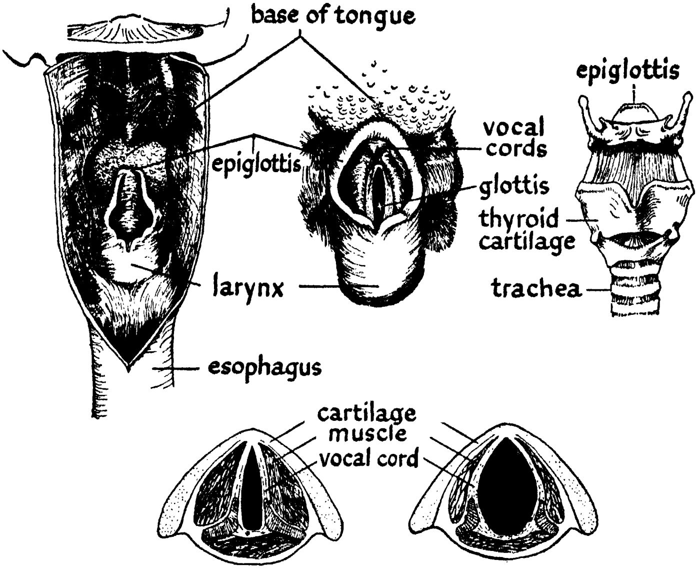
All these air passages are lined with mucous membrane which is richly supplied with blood vessels. If you breathe through your nose, this lining warms and moistens the air before it enters the lungs, while hairs at the entrance of the nostrils strain out the dust. Nose breathing also protects the delicate lining of the throat from becoming irritated by cold air.

The reception hall — the pharynx. Previously we have referred to the pharynx as the throat. It is not an organ but is merely the open space between the cavity of the mouth and the esophagus. Into it open the two nasal passages, an air tube from each ear called the *Eustachian* (ū-stā′kĭ-ăn) *tube*, the mouth, the esophagus, and the windpipe. Find these in Fig. 53.

Because of the ease with which infection may travel from one to another of these seven openings, the care of the pharynx is particularly important. A sore throat should never be ignored. A safe and helpful gargle consists of a teaspoonful each of salt and bicarbonate of soda to a pint of hot water. If the soreness persists more than a few hours, however, consult a physician.

The larynx. The larynx is composed of pieces of cartilage which form a triangular enlargement at the top of the windpipe (note Fig. 54). Two of these pieces are fairly large plates joined together to form a sharp V in front, known as the "Adam's apple." Sounds are made by the vibration of two *vocal cords* which are attached to the front and back of the cartilages on each side of the larynx. The cords are fibrous, elastic bands covered with mucous membrane. When you breathe out you send air through the narrowed opening forcefully enough to set the edges of the cords vibrating. The cords in turn set up sound vibrations in the air, in a manner similar to the action of violin strings. When you wish to speak or sing, certain small muscles move the vocal cords inward and outward, changing the tension on them and hence changing the pitch (see Fig. 55, lower half). You can never speak while breathing in. Try it. (Practical hints on speech improvement are given on page 396.)

Hallways to the lungs — windpipe, bronchi, and bronchial tubes. Of course, the goal for incoming air is the lungs. After passing through the voice box it continues on down the windpipe, or *trachea.* This is a noncollapsible tube about an inch in diameter and 4½ inches long. Feel your own windpipe below the larynx.

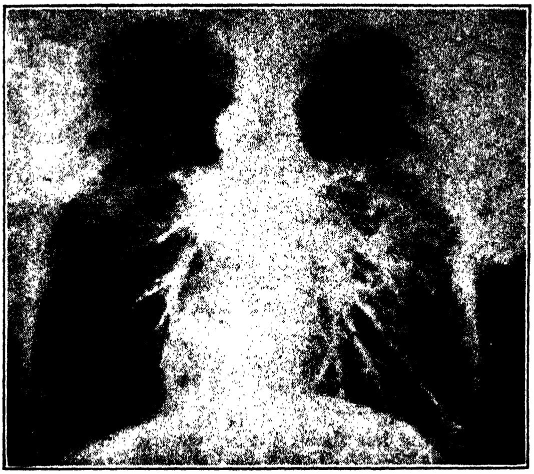


54 The drawing at the left shows the larynx and surrounding organs. More details are shown in the other drawings. What does breathing have to do with voice production?

Do you note that it feels corrugated? This is because its fibrous walls have horseshoe-shaped pieces of cartilage embedded in them. The open ends of the cartilage strips are connected in the back by bands of muscle. The esophagus lies directly behind the windpipe and comes in contact with this flexible portion so that food can be swallowed more easily. Can you see why this noncollapsible structure of the windpipe is a protection to your very life? Another interesting feature of the windpipe is its lining of ciliated epithelium. Read again the description of this on page 30.

At its lower end the windpipe divides into two smaller tubes called the *bronchi* (brŏn′kī). Each bronchus penetrates the lung on the respective side of the body and then breaks up into many smaller branches called *bronchial tubes*. Note how these appear in the X-ray photograph, Fig. 55. The bronchial tubes divide and redivide until they become tiny tubes reaching into all parts of the lungs. Inflammation of the bronchi is called *bronchitis* (brŏn-kī′tĭs).

Where the blood conditioning is done — the lungs. In order to fulfill its purpose of supplying oxygen to the blood and receiving from it carbon dioxide, the air must be exposed to as many capillaries as possible. To accomplish this, each of the tiniest bronchial tubes ends in a group of little air sacs called *alveoli* (ăl-vē′ō-lē), as shown in Fig. 56. These resemble clusters of grapes except that each alveolus is microscopic in size and is hollow inside. The capillaries surround the alveoli. The blood and the air are separated by only two thin layers of tissue through which the oxygen and carbon dioxide must pass by osmosis. What layers are these?



55 X-ray of the chest with injection of lipiodol (an insoluble substance). (Fig. 136, p. 571, Heuer, G. J., Surgery of the Thorax, Nelson's *Loose-Leaf Surgery* Vol. IV, Thomas Nelson & Sons, New York)

It has been estimated that there are more than 700,000,000 alveoli in the lungs and that their entire inner surface is more than a hundred times that of the body. All these hollow air spaces make the lungs so light and puffy they will float in water.

Each lung is enveloped by a tightly fitting membrane called the *pleura* (plo͝or′*ȧ*), which turns back and lines the chest cavity. The enclosed space between the membrane covering the lung and that lining the chest is called the *pleural cavity.* When the lungs are filled with air, the two pleural layers are close together, and in health there is always a little fluid between them to prevent friction as they glide one upon the other with each movement of the chest. When the pleura becomes inflamed, the rubbing of the two layers together during breathing causes severe pain. This condition is called *pleurisy*.

MAINTAINING THE BREATH OF LIFE

The term *respiration* includes all of the processes involved in supplying the body cells with oxygen and ridding them of carbon dioxide. These processes are: (1) breathing, or taking in and expelling air from the lungs; (2) the interchange of oxygen and carbon dioxide between the air sacs and blood cells; and (3) the passage of oxygen from the blood cells via the lymph into the body cells, and of carbon dioxide from the body cells via the lymph into the blood.

How you alter the air you breathe. The air you expire has been changed in your lungs in the following respects: (1) it is several degrees warmer; (2) it has absorbed much moisture evaporated from your lungs; (3) it has about 4.94 per cent less oxygen and 4.35 per cent more carbon dioxide; and (4) it has a greater volume because it is expanded by heating and has had water vapor added.

The foregoing facts indicate that good ventilation is of primary importance to health. Your lungs can make these changes and utilize air better if that air satisfies the requirements of moisture and temperature which you studied in connection with ventilation (Problem 9). Moreover, crowded rooms soon become very warm and moist if the air is not changed constantly because each individual alters a considerable volume of air in a short time (Fig. 59).

How you breathe. You inhale and exhale by alternately increasing and decreasing the size of the chest or thorax (thō′răks). The chest is a closed cavity within the rigid framework of the spinal column, ribs, and breastbone. Between and over these bones lie muscles. A dome-shaped muscle called the *diaphragm*, just above the stomach, forms a movable bottom to this airtight cavity.

When you inhale, the chest cavity is enlarged by two methods: (1) by contracting the chest muscles, thus raising the chest wall upward and outward; and (2) by pulling the diaphragm downward. When the chest cavity is thus enlarged, its inside pressure is decreased and outside air rushes into the lungs.

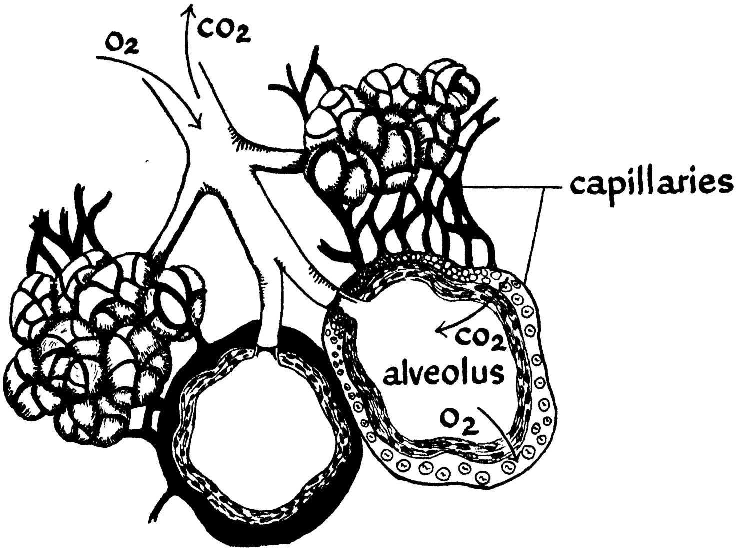
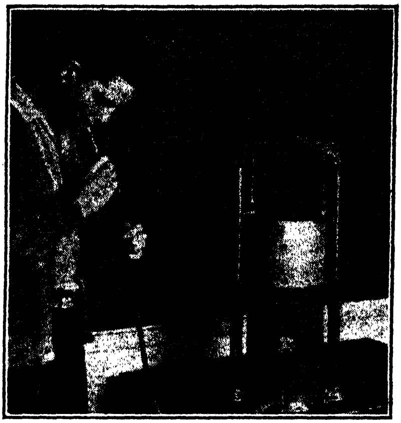


Diagram to show detail of lung structure. What change takes place in the blood as it passes around the air sacs (alveoli)?

During expiration the reverse action occurs. The diaphragm and chest muscles relax and the chest partially collapses, pressing on the lungs and forcing the air out of them. Normal expirations do not require much effort on your part. This is not like *forcing* the chest to become smaller in size, for then you must contract two other sets of muscles, one between the ribs and one in the walls of the abdomen. These muscles do only a little work in ordinary breathing, though experiments indicate that you probably should train them to do more.

Types of breathing. Some people do chiefly "rib breathing" (by making the chest rise and fall); others "diaphragm breathing" (using the diaphragm only). It is desirable to make use of both kinds, for then the air is properly renewed in all portions of the lungs. *Full breathing is a natural result of good posture plus strong diaphragm and chest muscles.* Stooped shoulders crowd the lungs so that they cannot expand. Your effort, then, should be centered on developing the muscles which hold you erect and those which govern breathing. Accomplish this by natural exercises such as hiking, swimming, rowing, and active games. These are better than



57 Measuring lung capacity with a spirometer. Air from the lungs raises the cylinder. A scale on the side registers amount of air blown in. Do you think he could raise it more after he practiced deep breathing for a month? What counts most in breathing?

formal breathing exercises because they stimulate the *whole* body, increasing circulation and the rate at which the cells use oxygen.

Lung capacity. Before birth a baby depends on the blood of the mother for its supply of oxygen and the elimination of carbon dioxide. The alveoli remain little solid tips at the ends of the air tubes until the baby is born and takes its first breath. Then they become inflated with air. After the lungs are once filled with air, no expiration can ever completely empty them. As the child grows, the lungs increase in size and in their capacity for holding air.

The amount of air one can force out after taking the deepest possible breath is called *vital capacity.* The amount of air that passes in and out with each quiet breathing movement is called the *tidal air.* Each of these depends on body size, build, muscular development, and breathing habits. For the average adult man, the vital capacity ranges from 3,500 cc. to 4,500 cc.[1] or 6 to 8 pints, whereas his habitual tidal air is only about one seventh of that or a pint.

The vital capacity can be measured by a *spirometer*, as shown in Fig. 57, or can be judged roughly by the homemade device shown in Fig. 58. It will be interesting to measure your own lung capacity and compare yourself with others of approximately your same size and build. If your capacity seems too small, then attempt gradually to improve it.

How breathing is regulated. You may have wondered why you breathe at regular intervals, though sometimes faster or slower according to your need for oxygen. All this is controlled by a group of nerves known as the *respiratory center* in the lower back part of

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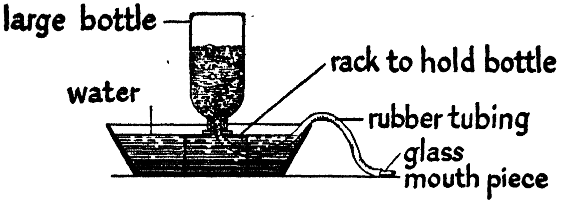
[1] cc. = cubic centimeter; 473 cc. = 1 pint.



58 A homemade spirometer can easily be contrived by inverting a large bottle full of water into a pan filled with water. Make comparisons of lung capacity by measuring the height of the air space in the bottle.

the brain. These nerves automatically stimulate the breathing muscles to contract. Chemical changes in the blood, especially in the amount of carbon dioxide, that bathes these nerves prompt this action.

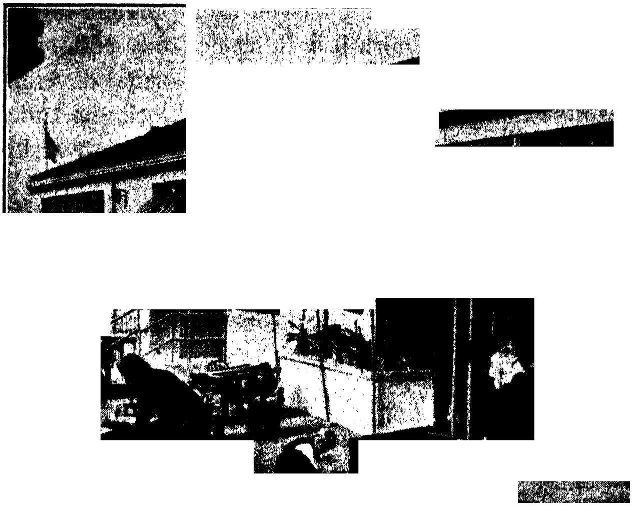
You breathe faster and deeper during exercise because carbon dioxide accumulates in the blood and causes the respiratory center to discharge breathing impulses more vigorously. Your breathing is also speeded up by emotional excitement because the respiratory center is stimulated by the secretion of the adrenal glands.

AVOIDING OBSTRUCTIONS OF AIR PASSAGES

If the air passages between the nose and the alveoli of the lungs are obstructed, a loss of efficiency results that may destroy health or life itself. Some of the common diseases which affect the respiratory system are colds, influenza, pneumonia, and tuberculosis. Since these are communicable diseases, they are discussed in Problem 23. Other conditions that must be guarded against are enlarged tonsils, adenoids, catarrh, and sinus disease. To these we now turn our attention.

Tonsils. Have you ever had a sore throat with swelling on each side? This is usually traceable to the sensitive lymphatic glands on each side of the throat, known as the *tonsils*. Their purpose is to filter out bacteria from the lymph and to dispose of them.

If the tonsillar tissues themselves become infected from bacteria in the mouth and throat, the poisons in them may spread through the lymph system and cause serious conditions in other parts of the body. Diseased tonsils frequently contain pockets of pus; they may or may not become enlarged.



59 The most modern schools are built to take full advantage of fresh air and sunshine. (Courtesy of Los Angeles Board of Education)

If a child has numerous colds and repeated attacks of sore throat (tonsillitis), it is fairly certain that the tonsils are diseased. Such a child should be examined by a physician and given *persistent care as directed.* Pus pockets are usually emptied by the doctor and the tonsils painted with an antiseptic. Unless a child becomes rheumatic or has constant colds, doctors usually advise retaining the tonsils until the age of three or four, at least.

Most physicians do not advise removal of tonsils at the first signs of infection, for the real cause may be some trouble such as faulty diet or poor elimination. An effort should be made to correct any such cause, build up the general resistance, and give the tonsils every chance to recover and to function normally. If they remain infected in spite of such treatment, then they should be removed. The removal of badly diseased tonsils in children and young adults almost always results in a marked improvement in health.

Adenoids. These are nodes of lymphoid tissue in the passage between the nose and throat; when enlarged they prevent proper breathing through the nose. Mouth breathing not only endangers health, but it may also seriously interfere with the normal development of the teeth. Enlarged adenoids sometimes block the tubes between the throat and middle ear — a condition which may result in partial or complete deafness.

Children with adenoids have a characteristic, unattractive expression; frequently they seem stupid and are backward in school. Since children do not outgrow them, adenoids become an increasingly serious handicap and should be removed at the first indication of trouble.

Dr. William Sadler says:

> There is no operation in modern surgery . . . which can exhibit such a triumph in the line of immediate achievement and spectacular results as the simple operation for the removal of adenoids. Within a few short weeks following the operation, the child develops a good appetite, rapidly puts on flesh, takes a new interest in work and play, sleeps well, exhibits marked increase in powers of attention . . . the entire expression of the face changes — begins to beam with intelligence; . . . in fact, the transformation is so marvellous, so complete, and so sudden, that it proves conclusively that the poisonous excretions of the adenoid mass were being carried by the blood stream to every cell of the brain and body.[1]

Nasal catarrh. An excess secretion from the respiratory mucous membranes is commonly known as *nasal catarrh.* Some of the causes are: deformities in the structure of the air passage; bacterial infection; exposure to wind, hot dry air, or irritating dust or fumes; unbalanced diet; and sudden chilling. *Hay fever* is a condition traceable usually to sensitivity to foreign proteins in certain foods and in the pollen of certain plants. This and other allergic conditions are discussed in Problem 23.

Chronic nasal catarrh often causes mouth breathing, headache, mental dullness, or poor general health. If the nasal passages are infected, a pus secretion may follow the watery one if nothing is done to check it. In all cases, a nose and throat specialist should be consulted. With the removal of the specific cause, the membranes soon return to normal.

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[1] Sadler, William S., *Essentials of Healthful Living*, The Macmillan Company, New York, 1925, p. 88.

Sinus disease. As shown in Fig. 53, the sinuses are cavities in the bones of the head. They open into, and have the same lining as, the nose and throat. Any catarrhal condition may spread into the sinuses; and when it does, it is very difficult to treat because the small openings readily become closed when the mucous membrane is swollen. This causes pressure and pain. In some cases minor surgery is necessary to re-establish drainage and ventilation of these cavities.

There are so many possible causes of sinus diseases that each case must be treated individually. Sometimes a change of climate or locality brings relief, especially if the condition is caused by lack of moisture or the presence of some irritant in the air in a certain region. If sinus infections accompany frequent colds and sore throats, special efforts should be made to build up resistance, especially through proper diet and an extra quantity of vitamins, particularly vitamin A.

Conclusion. The respiratory system takes in oxygen and eliminates carbon dioxide for all the cells of the body. These gases are exchanged through a thin membrane between the lungs and the network of capillaries around them. Hence, if your air passages are obstructed or you do not use your lungs sufficiently, your whole body may suffer loss of efficiency or health because of the lack of oxygen.

Since you normally fill your lungs only about $\frac{1}{7}$ of their capacity, you should exercise at least once daily strenuously enough to fill them to full capacity and completely change the air in them. Develop better breathing habits by natural exercise and good posture. Help keep the membrane of your whole respiratory system in good condition by a sufficient supply of vitamin A and by a responsive heat-regulating system that makes you less susceptible to chilling.

ACTIVITIES

1. **Self-check on your study of this problem.** See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. **An exciting dissection.** From your butcher obtain a pair of lungs with the windpipe attached. Wash the end of the windpipe thoroughly

and wrap it with clean cloth, leaving the end open. Blow up the lungs by mouth. Thereafter, do they collapse completely or do you have to press on them?

Try to press the windpipe flat with your fingers. With scissors slit the windpipe. Note its structure. What are the strips of white material? What are they for?

Locate the bronchi. Continue slitting one bronchus and follow it into the lung. What happens to it?

Slice across a piece of lung close to the end of the windpipe, another toward the center of the lung, and one near its outer edge. What are the tough rings you find in each? How do they compare in size? Explain.

Cut off a piece of lung and put it in a basin of water. Explain the result.

With a razor blade cut thin slices of lung and examine under the microscope. Can you locate alveoli and capillaries?

Your Health Habits

Check yourself on the following habits. Do you —

a. Breathe through your nose?

b. Fill the upper corners of your lungs with *each breath?*

c. Expand your lower ribs with *each breath?* (To test this, place hands over lower ribs, with fingers just touching, as shown in Fig. 60. Take a deep breath and let someone else see if fingers are *forced* apart *naturally;* don't *pull* them apart.)

d. Exercise each day vigorously enough to increase your breathing?

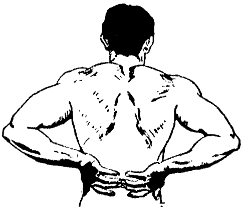

FIG. 60

e. Get some outdoor exercise daily?

f. Work, play, and sleep in well-ventilated rooms?

g. Get and obey advice from a physician if you have even a suspicion of any respiratory disorder such as diseased tonsils, adenoids, catarrh, or sinus trouble?

3. Measuring your lung capacity. With an apparatus like that shown in Fig. 57 or Fig. 58, measure your lung capacity. Compare with several other pupils of about your age and size. Practice good posture and deep breathing for a week and measure again.

4. Key words. Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each:

respiratory system
respiration
pharynx
larynx
trachea
bronchial tubes
alveoli
diaphragm
lung capacity
tonsils
adenoids
sinuses

SUGGESTED REFERENCES [1]

Cockefair, E. A., and Cockefair, A. M., *Health and Achievement*, Ginn & Company, New York, 1940. (Use index.)

Crisp, Katharine B., *Be Healthy*, J. B. Lippincott & Co., New York, 1938, pp. 100–116.

Harding, T. S., "Great American Rite; What Many Doctors Think About Removal of Tonsils," *Scientific American*, July, 1939.

McEachern, Margaret, "Do You Snore?" *Hygeia*, February, 1938.

Pearlman, Louis M., "Can Sinus Be Cured?" *Hygeia*, October, 1938.

Williams, J. F., *Healthful Living*, The Macmillan Company, New York, 1941. (Use index.)

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[1] Use also books in *General References* in the Appendix.

Unit V. *Achieving Skillful Motion and a Pleasing Appearance*

THE desire to be pleasing is a natural impulse in both men and women, but unfortunately modern advertising has directed it into artificial channels. Many people depend largely upon cosmetics and jewelry for physical attraction instead of developing the body's innate beauty.

Frequently, as a stranger approaches, you form some opinion of his personality from his general physical appearance. At a distance you judge him by his general posture, which depends chiefly on his *bone structure.* At closer range you are impressed by the lines and movement of his body, which depend on the type of *muscles* he has developed and *the way he habitually uses them.* To remain attractive under close scrutiny he must also have a clear firm *skin* and well-kept *hair* and *nails.*

This unit will give you practical assistance in making your body strong, responsive, and pleasing. The mental aspects of personality, without which even the finest body is a mere shell, are discussed in Unit VIII.

Problem 12. *How Can Bones and Teeth Contribute to Personal Appearance?*

A stature undepressed in size
Unbent, which rather seemed to rise
In open victory. — WORDSWORTH

STUDY OUTLINE

A. The body's framework
  1. How can scientists tell from what kind of an animal and from what part of the body a single bone came?
  2. What is the backbone like? How is it held erect?
  3. Why can some joints bend only one way, while others move in several directions?
  4. Why don't bones jar and scrape together at joints?

B. How bones grow and repair themselves
  1. What food substances are used for bone building?
  2. Why do some people's bones break more easily than others'?
  3. How does a broken bone grow together?
    a. How are bone cells placed so as to get building material from the blood?
    b. How do the "soft spots" in a baby's head fill in?
    c. Why are fractures more serious for old people than for children?

C. Good posture: How to develop and maintain it
  1. How can such defects as round shoulders, curvature of the spine, and flat feet be prevented and overcome?
  2. How can you test your own posture?
  3. What are the requirements in a properly fitted shoe?

D. Why teeth need special care
  1. How is a toothache caused?
  2. Why can a "baby" tooth be replaced while a permanent one cannot?
  3. How can you keep your teeth beautiful and healthy?

THE shape and size of your bones determine your individual body form, your features, and to a large extent the way you move. You cannot change this. *The manner in which you use your bones*, however, produces a far more noticeable effect upon your personality than does the way the bones are built — and this is within your power to control. It depends upon the way you train your muscles to support and move the bones habitually.

THE BODY'S FRAMEWORK

All mammals, including man, have the same number, plan, and arrangement of bones, with the exception of tails and hoofs. The differences between the neck of a giraffe and that of a mouse, and between the speed of a deer and that of a hippopotamus, are due primarily to variation in the shape and size of their bones.

Man owes his superiority over other animals not only to his greater brain power but to a better body through which his brain can express itself. Two features are outstanding in this respect: (1) the shape of his legs and the way they are slung in their sockets enables him to stand upright and to use his hands for other purposes; (2) his hands with their fingers and opposing thumb are capable of an infinitely greater variety of motions than the most complicated machine. (See Fig. 62.)

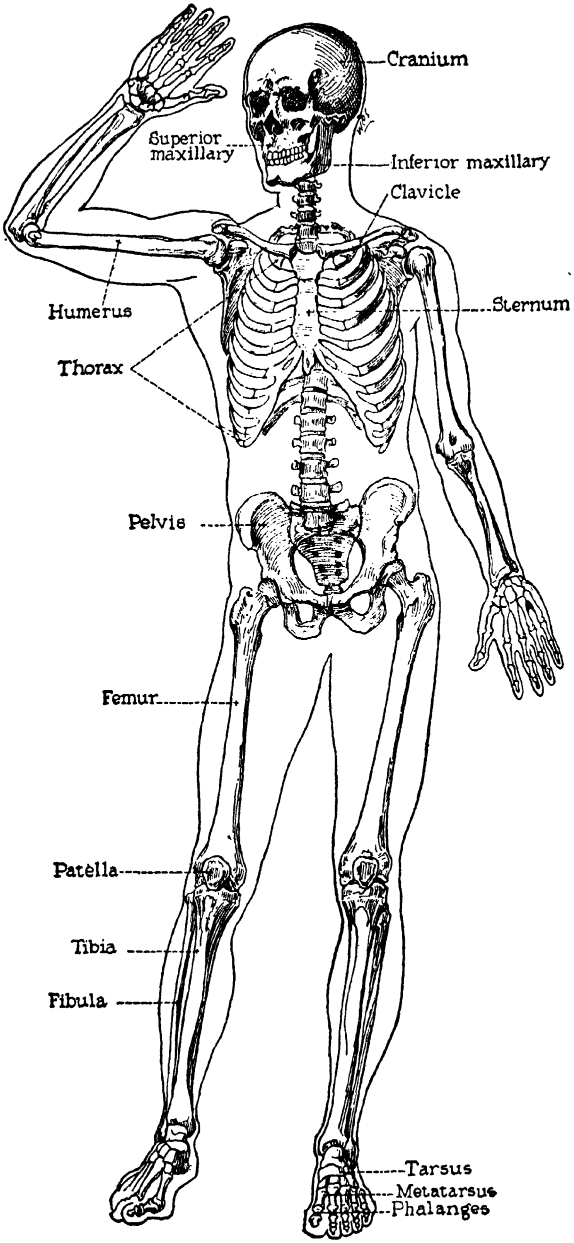
Uses of the skeleton. Have you ever wondered just why you have a skeleton? Its three functions may be stated briefly:

1. *To aid movement* by serving as an attachment for muscles. Muscles themselves can contract only a short distance; but since they are attached to bones, their action is increased both in intensity and range. (See Fig. 82.)

2. *To support the body* by giving it a rigid framework.

3. *To protect the vital organs.* The ribs, spinal column, and hip bones support and protect the organs of the abdomen and chest; the skull protects the brain; and the spinal column protects the delicate spinal cord.

Parts of the skeleton. In studying this section make frequent reference to Fig. 61 or, better still, to an actual skeleton. For most people, learning the *scientific names* of bones is impractical. You may learn as many or as few as you need. The important thing is



61 The human skeleton. (From *The Human Body*, by Logan Clendening, Alfred A. Knopf, Inc.)

to understand how the bones fit together and how you may use them with least effort.

The skeleton of most mammals consists of a *head*, *trunk*, and four *legs*, or *appendages*. The *spinal column* is the central support for the whole body.

In man, the *skull* is composed of the *cranium* (8 bones) which encloses the brain, and the *facial skeleton* (14 bones). The skull bones of an infant have small spaces between them filled with a membranous structure. These spaces, called *fontanels* (fŏn′tȧ-nĕls′), gradually fill in with bone; and at 18 months of age the entire skull is firm.

The *spinal column* is of great importance. In an adult it contains 26 bones. The *sacrum* (sā′krŭm) (see Fig. 63) is composed of 5 bones fused into one, and the *coccyx* (kŏk′sĭks) of 4 bones in one. The 24 bones above the sacrum are called *vertebrae* (vûr′tē-brē). The uppermost 7, the *cervical* (sûr′vĭ-kăl) vertebrae, form the neck. The 12 below this, the *thoracic* (thō-răs′ĭk) vertebrae, serve as attachments for the ribs, there being one pair of ribs for each vertebra. The next 5 vertebrae form the *lumbar* region or the "small of the back," to which no bones are attached. The sacrum has attached to it the pelvic or hip bones.

Each vertebra (Fig. 64) is an irregularly shaped bone with a hole in the center of it. The holes fit one over another so as to form a continuous opening, the *spinal canal*, throughout the length of the spinal column. This long hollow space houses the *spinal cord*,[1] which is composed of nerves and is continuous with the brain. Between each two vertebrae there are side openings through which nerves pass from the spinal cord to all parts of the body (Fig. 65).

Between the vertebrae, pads of *cartilage* act as shock absorbers and help to bind the vertebrae together. The spinal column is held erect by strong ligaments and muscles. When the muscles on both sides pull equally, the bones are held in line, one above another. When you bend in any direction, you contract or shorten the muscles on one side. Such motion is limited by the cartilage padding and by non-elastic ligaments. It is further limited, particularly in backward motion, by the ribs and the projections, or *processes*,[1] on the vertebrae which come together if moved too far. You can feel some of these processes along the back of your spine.

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[1] The reader should distinguish between these terms and have a clear idea of their relationship:
"spinal column" — *bones* or vertebrae;
"spinal canal" — a canal-like *space* within the spinal column;
"spinal cord" — a cable of *nerves* within the spinal canal.

62 Some authorities claim that man's superior mentality is traceable to his efficient hands with their flexible thumbs.

Viewed from the side, the spinal column shows four natural curves (Fig. 63). These compensate for each other without strain on the muscles, as the alternate ones are curved in opposite directions. Locate these in your own spine.

The *chest* or *thorax* is formed by the twelve pairs of ribs, the spinal column, and the breastbone. The front end of each rib is composed of cartilage. The uppermost seven pairs, called *true ribs*, are attached directly to the breastbone. The remaining five pairs are called false ribs because three of them are connected to the cartilage of the rib above and the lowest two pairs are not attached in front at all. The latter are called *floating ribs*. The ribs are moved by means of muscles attached to the vertebrae and also by muscles and ligaments stretched directly between the ribs.

The *arms* are hung from the trunk by means of the *shoulder girdle*, made up of the two collar bones and the two shoulder blades. Since the upper arm has but one bone and the forearm two (Fig. 61), you can twist your forearm and wrist while your upper arm is held steady for support. Try it.

Your *wrist* is composed of 8 small bones bound together tightly and not easily broken. The body of the hand is formed by 5 long bones while each finger has 3 bones, and the thumb 2. Locate them.

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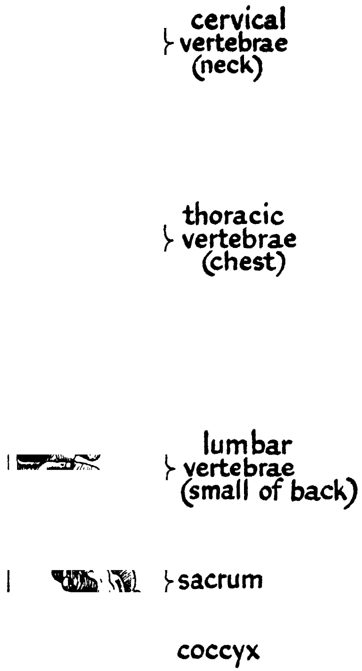
[1] A *process* is a prominent projection or outgrowth.

The *legs* are fastened to the trunk by the *pelvic* or *hip girdle,* composed of the two pelvic bones and the sacrum (Fig. 61). The leg bones correspond to those of the arms except that the ankle has one bone less than the wrist and the knee is protected by the *knee-cap.*

The *foot* proper is composed of two long arches, the longitudinal arch extending from the heel to the toes on the inner side of the foot, and the transverse arch extending across the ball of the foot. Many foot troubles are traceable to abnormal structure of these arches, or to improper development or care of them. Good walking habits and properly fitted shoes will aid in correcting the latter.



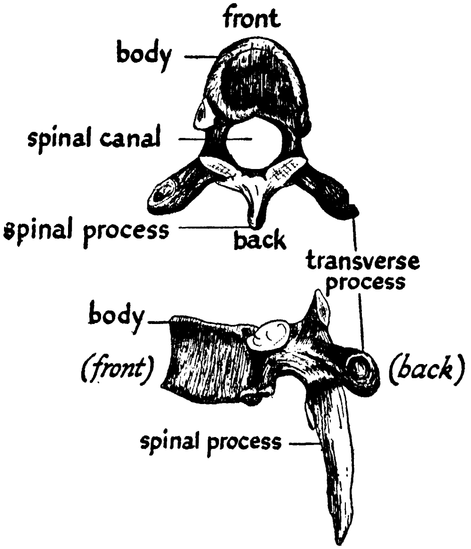
63 The spinal column seen from the side. Note the natural curves in comparison with the plumb line.

How bones are jointed together. There are many different kinds of joints in the body — too many even to mention in a text such as this. They may all be classed, however, as immovable, slightly movable, or freely movable joints.

In the *immovable joints* the bones are interlocked by a series of processes and indentations with fibrous tissue between them. These joints form jagged lines known as *sutures,* such as those seen on the skull.

The *slightly movable* joints are many, such as those between the vertebrae and between the sacrum and pelvic bones. Here the bony surfaces are joined together by broad, flattened disks of fibrous cartilage that can be compressed and stretched a little to permit slight motion.

The *freely movable* joints are by far the most numerous. Study a typical one such as any finger joint. Where the ends of the bones



64 The sixth thoracic vertebra. The upper view shows the vertebra from above; the lower one is a side view.

come together (Figs. 61 and 66), they are enlarged into heads. This gives them a larger contact surface and also strengthens the joint. Each head is covered with smooth, tough *cartilage* (gristle), which helps the bones to glide on each other and also takes up some of the shock when the joint is pressed together.

The bones are held together by strong ligaments attached to the outside of the bones above and below the joint. One of these ligaments (the *capsule*) surrounds the whole joint in a closed airtight sac. This sac is lined with a thin *synovial* (sĭ-nō′vĭ-ăl) *membrane*, which secretes a thick fluid resembling the white of an egg. This *synovial fluid* lubricates the joint. It is secreted continuously, but only as fast as the fluid is used up by exercise.

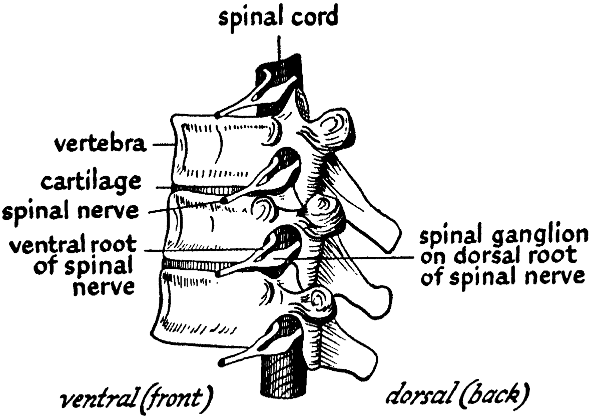
Movable joints are of many different types and allow a wide variety of motions: (1) *gliding joints* have nearly flat surfaces that glide over each other like those in the wrist; (2) *hinge joints* open only one way like a door and are found in the fingers, elbows, and knees; (3) *pivot joints* allow rotating movements, such as turning or pivoting your head, which is made possible by the joint between the first and second vertebra; (4) *ball and socket joints* have a ball that rotates in a socket, as in the shoulder and hip joints (Fig. 61).

HOW BONES GROW AND REPAIR THEMSELVES

Do you think bones are hard, nonliving structures? Consider for a moment and you will realize that they must be alive, for they grow in length and strength, and can mend a break quite easily.

Have you ever noticed how pink a fresh bone is? The color is due to its blood supply which nourishes the living cells. How bones can be so hard and still be alive is indeed surprising, but even more so is the process by which bones develop.

What bones are made of. Living or *animal matter* comprises one third of the bone, while the other two thirds consist of nonliving *mineral matter*. The animal matter is composed of cells, blood vessels, fat, and a fibrous gelatin substance. Soak a bone in strong vinegar for several days to dissolve out the mineral matter. The resulting animal-matter "bone" will look like the original one, but it will be tough and flexible and can be tied in a knot. Evidently, the animal matter makes bones tough and hard to break.


spinal cord
vertebra
cartilage
spinal nerve
ventral root of spinal nerve
spinal ganglion on dorsal root of spinal nerve
ventral (front)
dorsal (back)

65 Relationship between vertebrae, spinal cord, and spinal nerves.

The mineral matter is chiefly calcium phosphate and calcium carbonate, which are primary raw materials for building bones.[1] To study the mineral matter, heat a bone for some time in an oven. This will remove the animal matter. The remaining mineral "bone" also will have the same shape as the original, but it will be very light in both color and weight and so brittle it may be crushed in the fingers. Mineral matter evidently makes bones hard and brittle.

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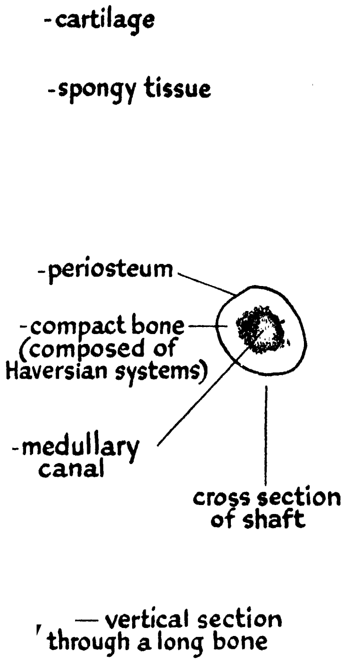
[1] Remember that the cells cannot build these into bone without the assistance of vitamin D. Thus *calcium*, *phosphorus*, and *vitamin D* are the great bone-building triumvirate. A deficiency of any of them causes rickets (page 56).


-cartilage
-spongy tissue
-periosteum
-compact bone (composed of Haversian systems)
-medullary canal
cross section of shaft
— vertical section through a long bone

66 Longitudinal section of a typical long bone. What purpose is served by the cartilage on the ends. See page 198.

In childhood and youth the proportion of animal matter is greater than in old age. For this reason children's bones are less brittle and do not break so easily. They also have better powers of growth and repair so that they mend quickly. The opposite condition in older people causes their bones to fracture more readily, and to heal less quickly.

How a bone is constructed. A typical long bone (Fig. 66) is covered on the jōint ends by cartilage, and everywhere else by a membrane called *periosteum* (pĕr′ĭ-ŏs′tē-ŭm). The periosteum contains (1) tough, elastic fibers for the protection of the bone; (2) a rich supply of blood vessels and nerves which send branches into the bone to nourish it; and (3) a special layer of cells which aids in building and repairing the bone.[1]

How bones live and grow. Microscopic studies of bone reveal a marvelous arrangement of living cells and blood vessels within a bony framework. The mineral bone is porous with little cavities in it arranged in concentric circles around canals which carry blood and lymph vessels. Within each cavity lives an isolated bone cell nourished by lymph which seeps out of the nearest canal and finds its way to the cells through tiny cracks in the bone (Fig. 8G).

Up to the age of 20 to 25 years, your bones are still growing; it is the tiny bone cells which must do the work of taking phosphorus, calcium, and a few other materials from your blood and depositing these about themselves in the form of bone. In babyhood, a large part of the bone-to-be is cartilage or membrane. At certain points the periosteum projects into the cartilage two types of cells: an advanced guard of cells to destroy the cartilage as they go, and bone-building cells to deposit bone material behind them. This process begins at both ends and works toward the center. When the two armies of bone builders meet, the bone is completely *ossified* and can grow no more. The bone cells that have been caught in the construction work and are left scattered throughout the bone remain there for upkeep and repair work on the bone.

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[1] The holes through which some of the blood vessels enter the bone can be observed on the surface of a dried bone. When the periosteum is peeled off, the bone underneath will die.

The process of ossification requires that the child have sufficient exercise to keep the blood in good circulation. By nonuse, due to paralysis or other disease, bones atrophy (waste away because of starvation) just as muscles do. Their disuse during adolescence may cause the bones of the unused part not to grow normally or even to cease growing before full development has been reached.

How a fractured bone heals. When a bone is broken, the blood plasma and white cells seep into the crack and form a gluelike substance called a *callus*, which sticks the ends of the bone together. This callus gradually ossifies by a process similar to the growth of bone until the new tissue becomes as hard as the bone proper.

GOOD POSTURE — HOW TO DEVELOP AND MAINTAIN IT

Are you sure you know what good posture is? You probably recognize it in other people, but do you know instantly when you are in good posture? This section gives some practical suggestions for developing good posture, but to benefit by them you must practice them constantly. *Posture is chiefly a matter of habit.*

How the skeleton may become deformed by poor posture. In addition to bone deformities caused by diseases such as rickets, arthritis, rheumatism, tuberculosis, or disturbed glandular function, certain conditions are traceable to purely mechanical factors. Such deformities result from some constant stress which pushes or pulls the bones out of their natural position. This may cause the bones themselves to grow out of shape or the cartilage between them to become thicker on one side than on the other, so that the joint itself assumes an unnatural slant. This is particularly true of the joints between the vertebrae, where the thick cartilage pads between them may easily become too compressed on one edge if the spinal column is constantly bent in the same direction. These conditions are of several types:

1. *Spinal curvatures of various types.* Typical causes: poor posture habits, wearing high-heeled shoes, carrying books or other loads always on the same side, working continuously at a desk and holding the head and shoulders too far forward, and other similar abnormal strains.

2. *Round shoulders.* Typical causes: poor sitting and standing posture, carrying heavy loads in the hands, and heavy labor in a bent-over position.

3. *Unequal length of legs.* Typical causes: constant skating with only one skate (always the same one), or pushing oneself with the same foot on a "scooter." Heredity appears to be a very important factor here also. In some families all children will show the same defect.

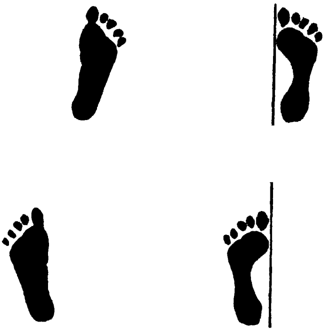
4. *Uneven shoulders.* Sometimes these result from uneven legs or a spinal curvature, or from holding the head always on one side.

5. *Misshapen facial bones,* particularly the upper jaw. This condition is due to adenoids, or such habits as mouth breathing or thumb sucking in early childhood.

It should be recognized that heredity may play a large part in some of these deformities, but just how much, is not known. If you have an actual hereditary condition, such as a short leg on one side, the only correction may possibly be a properly adjusted shoe wedge or other mechanical device, prescribed by an orthopedic surgeon.

To avoid acquired deformities you will have to learn exactly what good posture is and then painstakingly assume it as often as you can think of it until finally your muscles have acquired the *habit* of holding the body straight. Braces and corsets should be avoided unless prescribed by a surgeon, as you are apt to rely on them and only weaken the muscles more. *A muscle is strengthened not by having its work done for it but by doing its own work.*

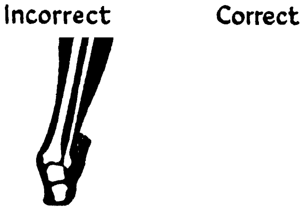
What good posture means. Posture means simply the way you hold your body. Unless you are sitting or standing still, your posture changes from moment to moment as you bend, lift things, and go through other motions of work or play. Also, whether you realize it or not, your body moves in response to your emotions and helps to express them. Good actors use this means to express fear or courage, hate or love, sorrow or joy, and you instinctively sense their feeling by slight changes in body posture, even before they speak. Accepted types of posture once followed styles, as clothes do. We have very nearly outgrown this foolish idea, however, and most stylists now realize that "good posture," physiologically, is likewise the most artistic and pleasing.



67 *Left.* Footprint of a flat foot. *Right.* Footprint of a normal foot with a moderately high arch. Compare your own with these.

This now makes it possible to agree on the definition that *good posture is that which conforms to the natural laws of mechanics and health of the body, i.e.,* it is that position for which the bones were built, and in which all the internal organs are held in proper position without sagging or abnormal pressure or strain.

How to use your feet correctly. Standing and walking require first of all the correct use of the feet; otherwise no part above can be properly balanced or poised. Carry the weight of the body slightly *on the outer side of the foot,* where there are bones to support it, while the inner side is off the ground. Keep the feet *parallel,* for then the bones, tendons, and ligaments are in their most natural position. If you toe out too much, the ligaments and tendons of the arches and leg are stretched so that the ankle tends to tilt inward (pronation), weakening the arches and causing back ache.



68 Walking with the toes turned out bends the ankle sideways and puts strain on the leg and back muscles (*left*). Keep toes pointed straight ahead (*right*).

Grip downward with the toes while standing and walking, to strengthen the arch across the ball of the foot. This also gives a buoyant spring to the step that makes for an attractive gait and contributes greatly to a sense of well-being.[1]

What kind of shoes to wear. The foregoing rules for proper foot use are difficult or even impossible to follow unless the shoes conform to the normal shape of the feet and are the right size. The length of the shoe should be such that the big toe, when lying straight, has a clearance of at least ½ inch from the end. To be sure of this, always try on both shoes while standing as well as sitting. In this way you may prevent ingrown toenails and other deformities which result from pressure of the shoes against the ends of the toes. The width of the shoe is also important in allowing for free motion and in preventing corns, which result from the pressure of too narrow shoes or the rubbing of too wide ones.

If the heel is too high (French heels on girls' shoes) it will place extra strain on both arches of the foot, and will throw the body out of alignment. It is almost impossible to keep the spinal column in proper alignment while walking on high heels. For daily use the heels (for girls) should be not more than 1¼ inches high, with the base nearly as broad as the top, to prevent the ankle from rolling.

Girls with strong arches may wear high heels occasionally, especially for dancing, as the weight is then on the balls of the feet anyway. Those having weak arches or poor posture, however, should never wear high heels until these weaknesses are overcome. Girls who wear high heels to school are indulging their vanity at the expense of their future health and efficiency. Besides, the added attractiveness (if any) of their feet is more than outweighed by the resulting unattractiveness of their posture.

How to strengthen weak or flat feet. When the ligaments have become stretched so that the arch is down, the condition is known as "flat feet" or "fallen arches" (Fig. 67). This interferes seriously not only with grace of movement but also with working power and resistance to fatigue. In fact, it is a cause for rejection of men from the army and of employees from some industries.

Some types of flat foot are traceable to hereditary causes. In

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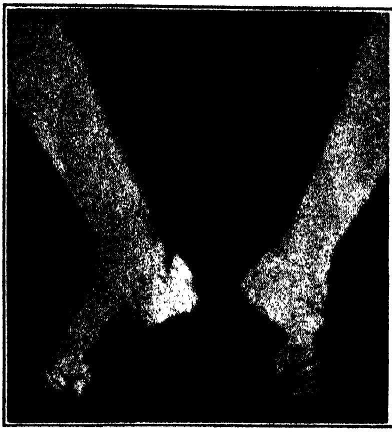
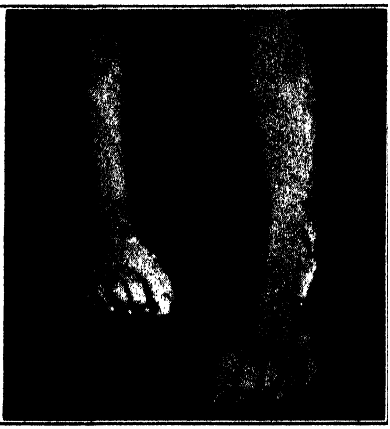
[1] Children naturally use their feet in this way and their arches are strengthened by going barefoot on grass or soft earth. They should not be permitted to play barefoot on cement or hard floors, however, as this will tend to break down the arches.

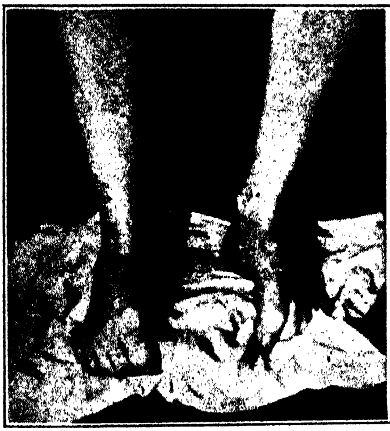
EXERCISES FOR STRENGTHENING ARCHES



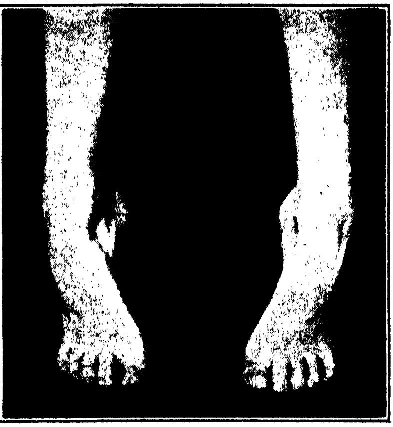
69 *The grip.* Sitting, feet on the floor in parallel position; tilt the feet sharply raising the inner borders while lifting the arches and flexing the toes. Repeat the exercise 25 times.



70 *The crow walk.* Walk with the weight on the outer borders of the feet, the arches lifted with the toes pointing inward, and grasping. Repeat the exercise for a number of steps at frequent intervals.

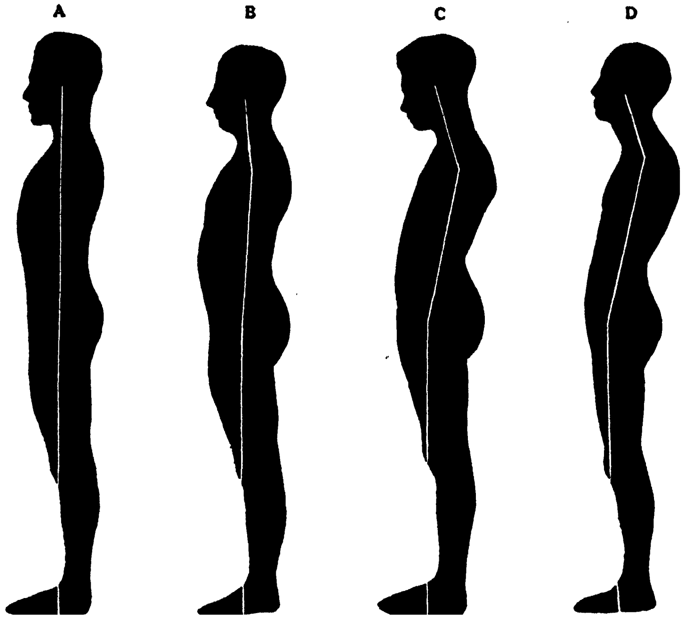


71 *The claw.* Sitting, with feet resting on a towel or other fabric. Grasp the towel vigorously with the toes while lifting the arches. Repeat the exercise 25 times alternating with the right and left feet.



72 *Tip toe.* Standing with toes turned inward, raise the heels and press outward and downward slowly, keeping the arches lifted. Repeat the exercise 25 times.

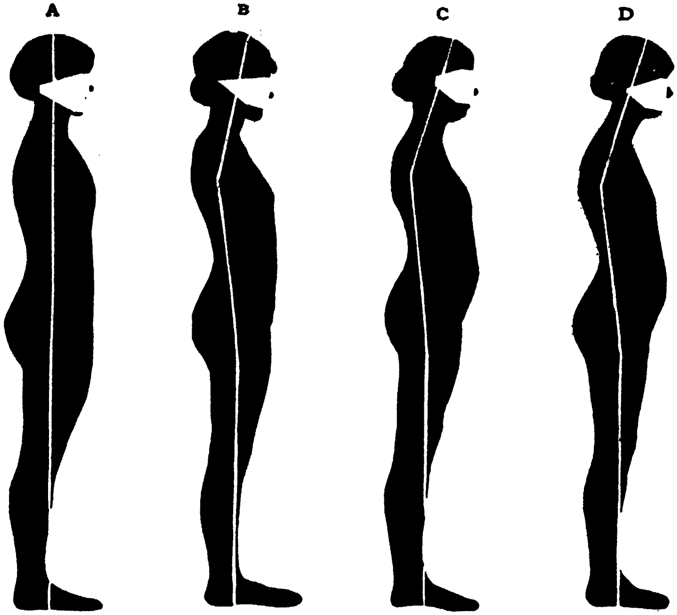
(All exercises from *How Do You Stand* by Professor
William R. La Porte, University of Southern California.)



73 How would you rate on this posture test? Note the straight and zigzag posture lines. A. *Good.* Head, trunk, and thigh in straight line; chest high, and forward; abdomen flat; back curves normal. *B. Fair.* Head forward; abdomen prominent; exaggerated curve in upper back; slight hollow in back. C. *Poor.* Relaxed (fatigue) posture; head forward; abdomen relaxed; shoulder blades prominent; hollow back. D. *Very poor.* Head forward badly; very exaggerated curve in upper back; abdomen relaxed; chest flat-sloping; hollow back. (Courtesy of The University of Southern California)

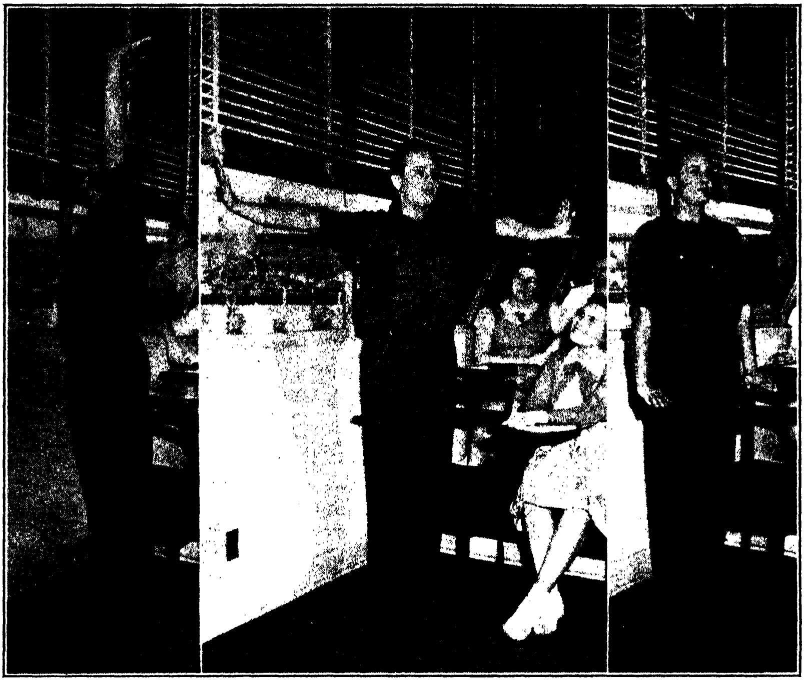
some such cases operations are successful. In others, the foot efficiency is not seriously impaired. In serious cases of acquired fallen arches an orthopedic surgeon should be consulted. In mild cases properly fitted shoes and persistent use of the exercises shown in Figs. 69 to 72 will prove helpful.

These exercises strengthen the ligaments and muscles of the foot, ankle, and calf of the leg, and keep all joints of the foot and ankle limber. If they do not improve the feet to a noticeable degree within a few months, assistance should be sought from an orthopedic surgeon. In severe cases *arch supports* may have to be worn *temporarily only*, but they *should never be relied on to take the place of foot exercises and practice in correct walking and standing.* Such arch supports should be prescribed and fitted by an orthopedic surgeon.



74 Don't let your clothes fool you. This is what posture does for your figure. A. *Good.* Straight line from ear through shoulder, hip, and instep; chest high; abdomen flat; back curves normal; weight over arches of feet. B. *Fair.* Head slightly forward; chest flat, shoulders slightly drooping; abdomen slightly protruding; back curve too great at waistline. C. *Poor.* Head forward; chest flat, shoulders drooping; abdomen decidedly protruding; extreme curve in back at waistline (hollow back). D. *Very poor.* Head drooping; chest flat, shoulders rounded and drooping; abdomen very protuberant; extreme hollow back; weight on heels. (Courtesy of The University of Southern California)

How to stand easily erect. Pleasing and healthful standing posture makes one alert and ready for instant action. He is poised and graceful, never stiff or awkward. To get your body in good posture hold your head as high as possible and balance a book on top of it. Now observe yourself in a full-length mirror with a hand mirror for assistance. Compare yourself with Fig. 73 or Fig. 74. If your posture is correct you will observe the following points: (1) your weight is over the *arch of the foot* so that you can raise either toes or heels a little without much change of position; (2) your *knees* are not stiff but are slightly flexed (limber knee action is important for a smooth "follow through" in sports); (3) your *lower back* is almost flat, only slightly curved (you may accomplish this better by pulling the buttocks down and under as



75 Good-posture exercises. *Left.* Notice how this straightens out the back. *Center.* Be sure to keep the back flat. *Right.* Hold your chest up. (See text.)

you would in squeezing through a narrow space); (4) your *abdomen* is held up naturally, almost flat, again as though squeezing through a narrow space (this is one of the most important health essentials, as sagging abdominal organs become sluggish because of poor circulation and loss of tone); (5) your *chest* is held high but relaxed, neither caved in nor forced out; (6) your *shoulders* are relaxed and your *arms* hang easily at your sides; (7) your *head* is poised above your shoulders, neither thrust forward nor back (get it right by stretching upward).

An excellent short cut for getting all parts of the body lined up at once with chest expanded, shoulders broadened, abdomen lifted and spine straightened, is the following simple exercise for establishing good posture:[1]

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[1] This exercise, followed by a few minutes of sitting relaxed and motionless in good posture, is an excellent method for resting both muscles and nerves. It may be used often during the day and may be performed by a whole class if desired.

1. Stand well balanced with feet parallel, a few inches apart. Keeping the spine flat, stretch both arms upward and push the palms up *vigorously* as if to push the ceiling out (Fig. 75 *Left*). Repeat three times, taking a deep breath with each upward thrust.

2. Same as (1), except arms are thrust out to sides as if to push the walls out (Fig. 75 *Center*).

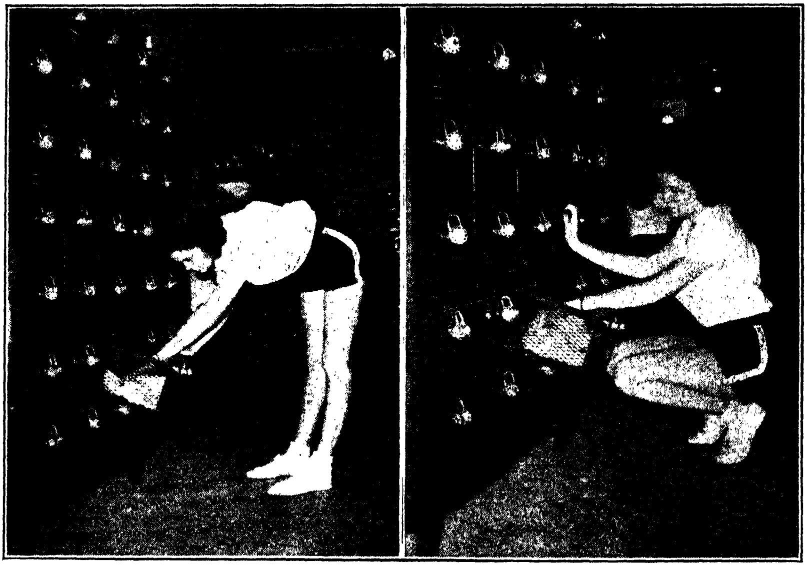
3. Same as (1) except arms are thrust downward close to the sides (Fig. 75 *Right*).

4. Now shrug the shoulders a few times, then relax them and let the arms hang loosely at the sides. Close your eyes if you wish, balance your weight over your ankles, narrow up your hips and abdomen, and then just think of yourself as being as tall as possible. Imagine yourself being lifted gently by two giant hands pressed carefully over your ears. *Keep your arms and shoulders relaxed* and imagine the top of your head pushing upward. Feel your spine straighten out.

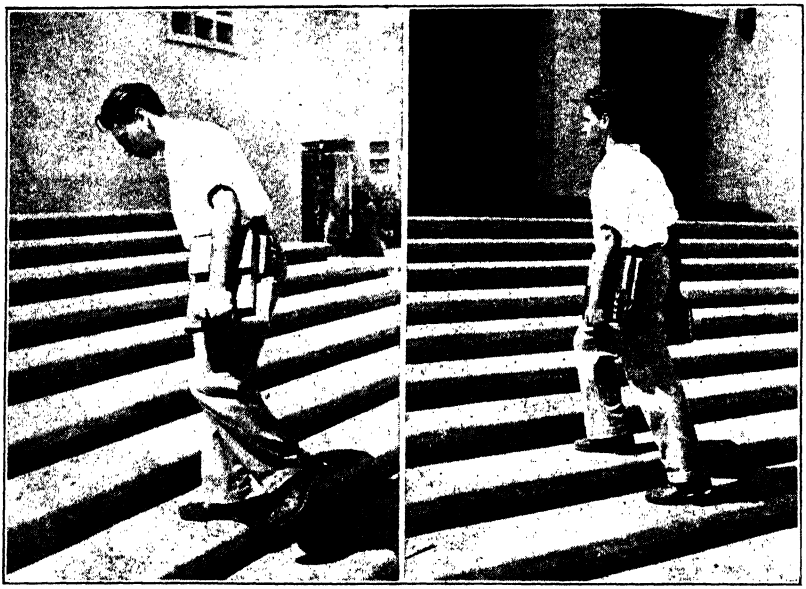
If you have done this exercise correctly *without tension*, your whole body should now have a good feeling that may be new to you. Just stand thus easily erect and enjoy the feel of it for several moments. You will also look your best, as your mirror will reveal.

How to look well while sitting. Good sitting posture is the same as good standing posture from the hips up and with the feet resting comfortably on the floor. First get into good standing posture, then hold the same position of trunk and head and sit down by placing the feet close to the chair and then merely bending the hip and knee joints. Let your hips come well back against the back of the chair, while your hands lie relaxed in your lap or on a table before you. *Sit tall but not stiff.* Breathe naturally. Contrary to ordinary belief by those who have never tried it, this position is the most comfortable and least fatiguing. It also makes a person look intelligent, alert, and interesting. If you need to bend forward as when eating or driving a car or working at a desk, *bend only from the hips*. This keeps all the organs in place and is likewise the most graceful and requires the least effort.

How to walk well with least effort. The feet should not be too far apart when walking, as that makes one waddle. The footprints should follow a straight line. Remember to keep the foot pointed



76 Don't bend down; keep your back straight and use your hip joints (as in the second figure). These joints were made to bend freely.



77 The hard and easy way to climb stairs. Keep your back straight and your head up, as in the second figure, and plant each foot firmly on the step. Note also the correct method of carrying books (in the picture at the right), with half in each hand to balance the load.

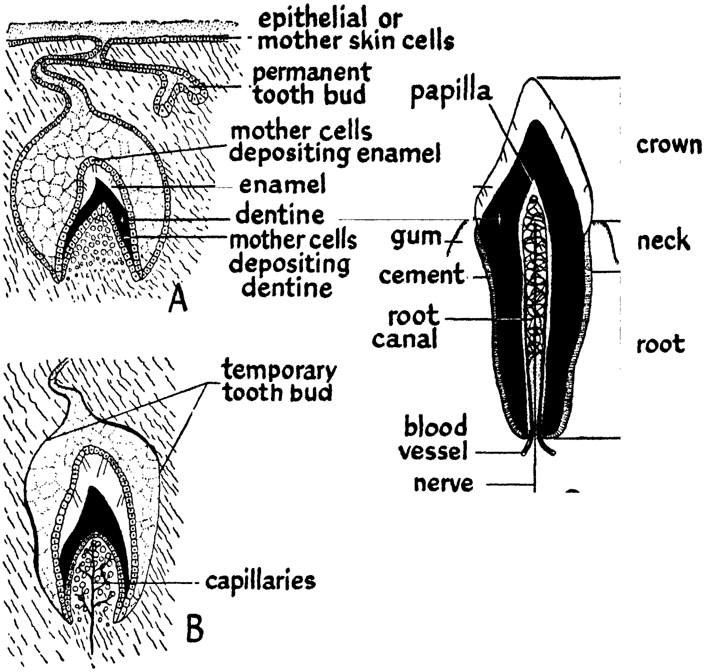
nearly straight ahead, put it down firmly with weight over the ankle, then transfer the weight smoothly to the ball of the foot as the body comes forward, and push off with the toes. (See frontispiece.)

How to practice good posture lying down. The easiest way to line up the body is while lying on the back on a medium or hard bed or the floor. Use a very small pillow under the head, or else none at all. Let the arms lie relaxed at the sides of the body, shoulders flat. Raise the knees, keeping the feet parallel on the bed. Stretch the spine as much as possible, especially flattening its middle and lower parts well down onto the bed while pulling the abdomen in and the chest up. Pull the hips together under you, then relax and gradually lower the knees until they rest on a small pillow which you have previously placed under them. The outer point of your shoulder, hip, knee, and ankle should now all be in a straight line. Incidentally, this is the best position in which to learn to relax, as explained in Problem 19.

WHY TEETH NEED SPECIAL CARE

No one will question that it is of primary importance for health and an attractive appearance that the teeth and gums should be kept in perfect condition, yet *how* to keep them healthy is a problem to which surprisingly few know the answer. It has been claimed that "a clean tooth never decays," but experience shows that something more than cleanliness is necessary for tooth health. Experiments in diet show that the health of the teeth depends not only on their *external* care but upon proper food *substances* in the blood from the very beginning of their growth. To appreciate all the rules for caring for the teeth you need to know what they really are and how they grow and live.

What teeth are. Though the outside part of a tooth is a hard, nonliving material, the tooth itself is *alive*, as you will suddenly realize if it develops a cavity and becomes sensitive to heat or cold. The main portion of the tooth is *dentine* (dĕn′tĭn) (Fig. 78C). The part of the tooth that projects above the gum is covered with *enamel*, which is harder and more shiny than dentine. The surface of the dentine that is below the gum is covered with a softer material called



78 A and B show how a tooth grows. Note that there are two layers of mother cells that build the tooth both from the inside and the outside. C shows the completed structure of a tooth.

cementum, which with its tight-fitting membrane attaches the tooth to its bony *socket* in the jaw.

In the center portion of the tooth is a *pulp cavity* filled with a soft pulp containing nerves and blood vessels. The health of the tooth depends upon how it is nourished from the capillaries in this pulp.

What keeps teeth alive. Science has proved that the capillaries must feed the teeth plenty of calcium, phosphorus, and vitamins A, C, and D, particularly C. For instance, in one noteworthy experiment, monkeys were fed a normal diet except that vitamin C was lacking. After a few weeks their teeth became loose in their sockets, and it was found that the pulp had actually shrunk away from the dentine. With the addition of a plentiful supply of vitamin C to their diet, the pulp cavity again filled up. This discovery was one step toward helping you to avoid a toothless old age.

More research work is being done constantly on the problem of tooth decay.

How teeth develop. Adequate nourishment for the teeth must begin before birth by proper feeding of the mother. The little teeth start developing between six and seven months before birth. Under the surface of the gum is a layer of epithelial cells (see page 27) called "mother cells" because they divide and subdivide to form new tissue. At intervals this cell layer forms a downward loop called a bud (Fig. 78A and B). At first there is one bud where each tooth is to be. Then each bud starts growing downward and divides into two; one grows farther down to form a temporary, or "baby" tooth, while the other branches to the side to develop, years later, into a permanent tooth (Fig. 78A).

As the baby tooth grows, it pushes upward through the gum. When it reaches the surface, it breaks through the mother cells and no more enamel can ever be formed. But the tooth keeps growing to full length by the addition of dentine from inside the pulp cavity. Finally *the fibers in the dentine shrink, leaving it slightly porous.*

Because of this porous nature, tooth decay progresses rapidly when once started. When the protective enamel is cracked or broken, bacteria can enter the pores. If the spot is not filled by a dentist, the decay spreads until the cavity becomes deep enough to admit food and cold air to the nerves, causing toothache. If decay progresses far enough to destroy the pulp, the tooth probably will develop an abscess on the root. This chain of events may be prevented or postponed by keeping the teeth clean and by being careful not to pick the teeth with hard metals, or bite on hard objects like nuts. To be certain no cavities have started, the teeth should be examined by a dentist at least once a year. He can fill any cavities before they have a chance to become large. This care is just as important for temporary teeth as for permanent ones, for the health of the first teeth influences the development of the second set and of the jaw bones.

How to keep the gums healthy. "Pyorrhea" is a term applied to a variety of disorders of the gums. Its cause is not yet fully understood, but in general the most common cases seem to be due to a chronic disorder of the whole system. The gums become tender and bleed readily. They gradually shrink away from the teeth.

79 Would your teeth permit a smile like this? Good, clean teeth contribute to both personality and health.

Pus pockets appear. In severe cases even the bone begins to be affected so that the teeth become loose in their sockets. As far as is now known, the best way of preventing this distressing condition lies in: (1) getting plenty of vitamin C; (2) preventing constipation and keeping the digestive tract healthy; (3) having a yearly dental examination at which time the dentist can scrape from the teeth any tartar deposits; (4) thoroughly brushing the teeth at least twice daily (after each meal if possible) according to the directions given below; and (5) stimulating the circulation in the gums by massaging them, by brushing them, and by eating daily some hard foods that require vigorous chewing, such as raw carrots, apples, and hard toast.

It has recently been discovered that some, but not all, cases of pyorrhea in early stages of bleeding gums yield to treatment with huge quantities of vitamin C. For a week the patient is given eight or more glasses daily of citrus-fruit juice, preferably orange juice. After that the quantity may be cut to a glass or two daily.

How to brush the teeth. Could you pass a tooth-brushing examination? Very few people could. To pass such a test you will need a stiff brush and some kind of mild cleanser. Tooth pastes and powders are helpful but not necessary; in fact, a few of these contain coarse scouring materials that are harmful to the enamel. Satisfactory materials are pure white soap, common table salt, baking soda, and most tooth powders or pastes.

Thoroughly brush the gums as well as all tooth surfaces. Place the brush tightly against the upper gum as high as possible and brush firmly down across the teeth. Similarly, on the lower jaw, place the brush as low as possible and brush up across the teeth. Brush all inner and outer surfaces this way. *Always brush the gums onto the teeth, never brush them away from the teeth.*[1]

Next, place the brush firmly against the grinding surfaces of the teeth and rotate it slightly so as to cleanse the crevices there. Lastly, clean the mouth by running the brush over the inner surfaces of the cheeks and over the tongue. Rinsing the mouth with a solution of one teaspoonful of salt, *or* the juice of a lemon, to a pint of water leaves the mouth refreshed. It is obvious that a thorough brushing of the teeth cannot be accomplished in less than three minutes. They should have this complete cleansing at least once a day, in addition to a simple brushing after every meal.

Summary of how to preserve the teeth.

1. Eat sufficient calcium and phosphorus daily (1 pint or more of milk).
2. Eat plenty of vitamin C (oranges, lemons, tomatoes, etc.).
3. Eat sufficient vitamins A and D (spinach, egg yolk, etc.).
4. At each meal eat some hard foods that require much chewing.
5. Massage the gums — always onto the teeth, never away.
6. Brush the teeth and gums after each meal.
7. Visit a dentist at least once a year for general cleaning and inspection, oftener if any tooth trouble occurs.

Conclusion. The shape and size of each bone fits it for its particular purpose. Bones are jointed together in different ways, thus permitting the most advantageous type of motion at each joint.

Bones and teeth are living structures that must be fed properly and must have good circulation of blood.

Broken bones heal easily in young persons if properly cared for. Elderly persons, however, should be carefully protected from falling since their bones break easily and are difficult to heal.

You need good posture to prevent deformities, hold internal organs in place, promote good circulation, and help you possess a vital and interesting personality. The habit of sitting and standing easily, tall but never stiff, helps promote good-looking posture.

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[1] If brushing seems too harsh on your gums, omit this part and, instead, massage with a piece of gauze wrapped around your finger, dampened, and dipped into a mixture of salt and soda in equal amounts.

Keep your back curves nearly flat, never exaggerated. You cannot walk gracefully unless you have comfortable shoes and healthy feet.

Health of teeth and gums depends on what and how you eat as well as on gum massage and daily brushing.

ACTIVITIES

1. **Self-check on your study of this problem.** See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. **Studying joints.** Obtain from the meat market some fresh joints: soup bone, knuckles, hoofs, rib attachments to vertebra, etc. Explain, with simple diagrams, how each joint serves its purpose, and how it is adapted to its particular type of action.

3. **Daily variations in height.** Measure carefully (three times and take average) the height of someone when he arises in the morning and again in the evening. Explain the difference. How is this phenomenon related to the fact that old people often decrease slightly in height?

4. **Posture silhouettes.** Make life-size shadow outlines of good and poor posture on plain wrapping paper. Let several pupils stand beside these for comparison with their own posture.

5. **Posture "stick figures."** Make sketches showing incorrect postures while sitting, standing, stooping, leaning, etc. Use a circle for the head, and single lines for the trunk, arms and legs. Use your unsuspecting classmates as subjects. Exhibit drawings and explain why each is bad from the standpoint of personal appearance, effect on friends, and effect on position and efficient functioning of internal organs.

6. **Demonstration of posture exercises.** Lead the class in practicing the exercises explained in this problem and any other good posture exercises you may know. Emphasize the importance of constant vigilance and habit formation.

7. **Testing your arches and shoes.** Dampen each foot and step normally on a piece of paper. Immediately outline footprint. Later, over the same prints outline the prints of your feet in stockings. Over this, in another color, trace the outline of your shoes. Now analyze your bare footprint as compared with that of a flat foot as shown in Fig. 67 at the left and that of a correct print as shown at the right. Explain whether your shoes and stockings give the natural foot freedom which is shown in your barefoot print.

8. **Key words.** Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each:

spinal column
joint
fallen arches
bone cell (and how nourished)
bone deformities
posture
pyorrhea (and its prevention)

Your Health Habits

Check yourself on the following habits. Do you —

a. Use your joints freely, especially the hip joints?
b. Exercise briskly each day?
c. Get plenty of calcium, phosphorus, vitamins C and D?
d. Stand and walk with toes straight ahead, weight on outer part of feet, and toes gripped?
e. Do you always wear well-fitted shoes with proper heels?
f. Do you keep your back and shoulders flat and your head up?
g. Do the chair and desk where you study or work help you to maintain good posture?
h. For the sake of your teeth, do you do *all* of the things mentioned in the Summary on page 215?

SUGGESTED REFERENCES[1]

Adams, Carl W., *Your Teeth and Their Care,** C. V. Mosby & Co., St. Louis, 1932.

Davis, M., "My Back Is Killing Me," *Pictorial Review*, **39** : 16–17, July, 1938.

Elder, V., "Trouble Teeth: Wisdom teeth, or third molars," *Parents Magazine*, **14** : 71, March, 1939.

Gulick, Luther H., *The Efficient Life*, Doubleday Doran and Co., Inc., Garden City, New York, 1928, Chap. V.

Lane, Janet, *Your Carriage, Madam!*, John Wiley and Sons, New York, 1934. (This is especially good.)

Palmer, Bissell B., *Paying Through the Teeth*, The Vanguard Press, New York, 1935.

Skinner, George A., "Wonder Stories of the Human Machine, The Framework," *Hygeia*, October, 1939.

Stratton, J. T., "Stand Up!," *Scholastic*, **34** : 27E, February 25, 1939.

Weinstein, G., "Keeping Posture Conscious," *Hygeia*, **16** : 652, July, 1938.

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[1] Use also books in *General References* in the Appendix.

* For advanced pupils and teachers.

Problem 13. *How Can You Attain Skillful and Efficient Motion?*

> The beautiful motion is that which produces the desired result with the least effort. — PLATO

STUDY OUTLINE

A. How skeletal muscles give the body form and motion

1. Why do amateurs look awkward when learning a new game?
2. How do muscles make bones move?
3. How are muscle cells arranged so as to pull together?
4. How are food and oxygen distributed to muscle cells?
5. Why does a muscle become paralyzed if its nerves are cut?
6. Why do you breathe hard after strenuous exercise?
7. What is the meaning of "muscular tone"?
8. How can awkwardness be overcome?

B. How other muscles compare with skeletal muscles

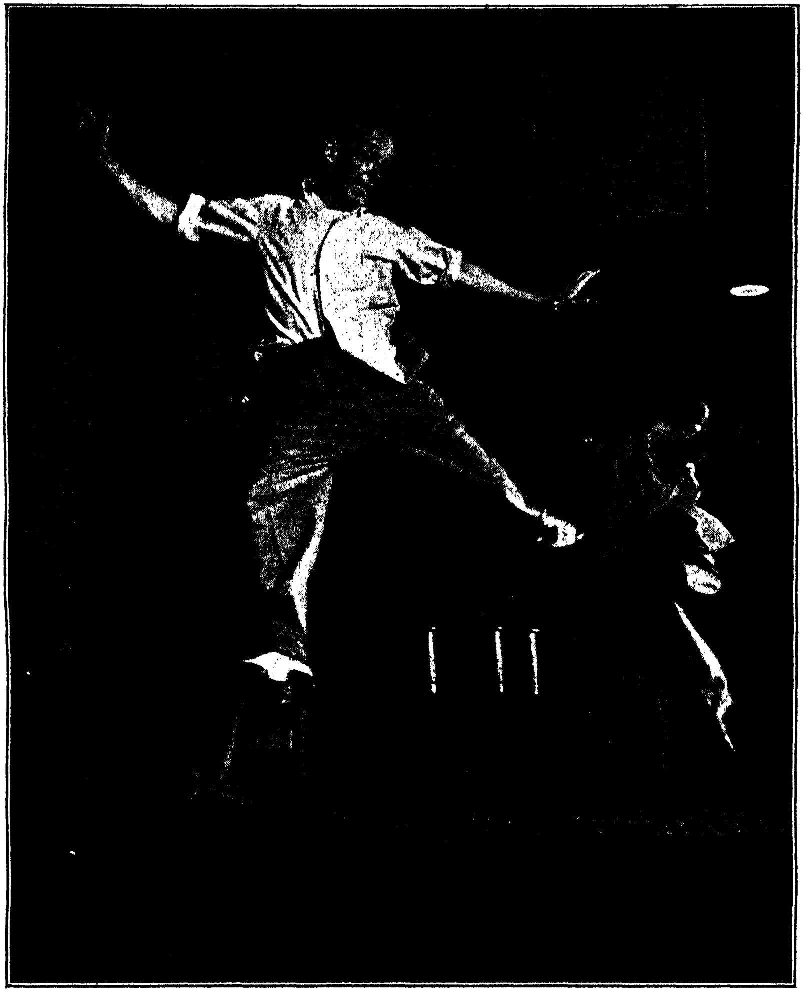
1. What type of muscle produces peristaltic action?
2. Why can't your brain control voluntarily the action of internal organs?
3. Do your thoughts affect internal action?
4. How does heart muscle differ from other muscles?

C. How to make your muscles work efficiently

1. What happens in a muscle to cause it to tire?
2. Why do you often tire more quickly indoors than outdoors?
3. Does hurry pay?
4. Are frequent rest periods a waste of time?
5. Why does music make exercise less fatiguing?
6. Of what advantage is a "warming-up" exercise?
7. What is the cause and treatment for common muscle injuries: strain, cramp, and severe bruise?

D. The kinds of exercise you should have

1. *Why* should you exercise?
2. What are the requirements of good exercise?



80 Fred Astaire has earned his position as greatest dancer in America by countless hours of this type of hard work. (Bob Landry from *Life*)

DOUBTLESS you have been thrilled many times at the apparent ease with which athletes and actors perform astonishing feats. Anyone who knows how to control and use his body well is consciously or unconsciously admired by all. Secretly every one desires a strong, lithe body that will give him a good appearance and will respond quickly and accurately to his every desire for action.

The development of such a body, however, requires conscientious practice.

Back of the thrilling pole vault, the forward pass, or the inspiring ballet lie hours upon hours, and even years, of patient training of the body muscles. Through the accurate study of how muscles work and how they may be used to best advantage, such experts have discovered many things which you and I may use to contribute to our health, efficiency, and personal attractiveness.

HOW THE SKELETAL MUSCLES GIVE THE BODY FORM AND MOTION

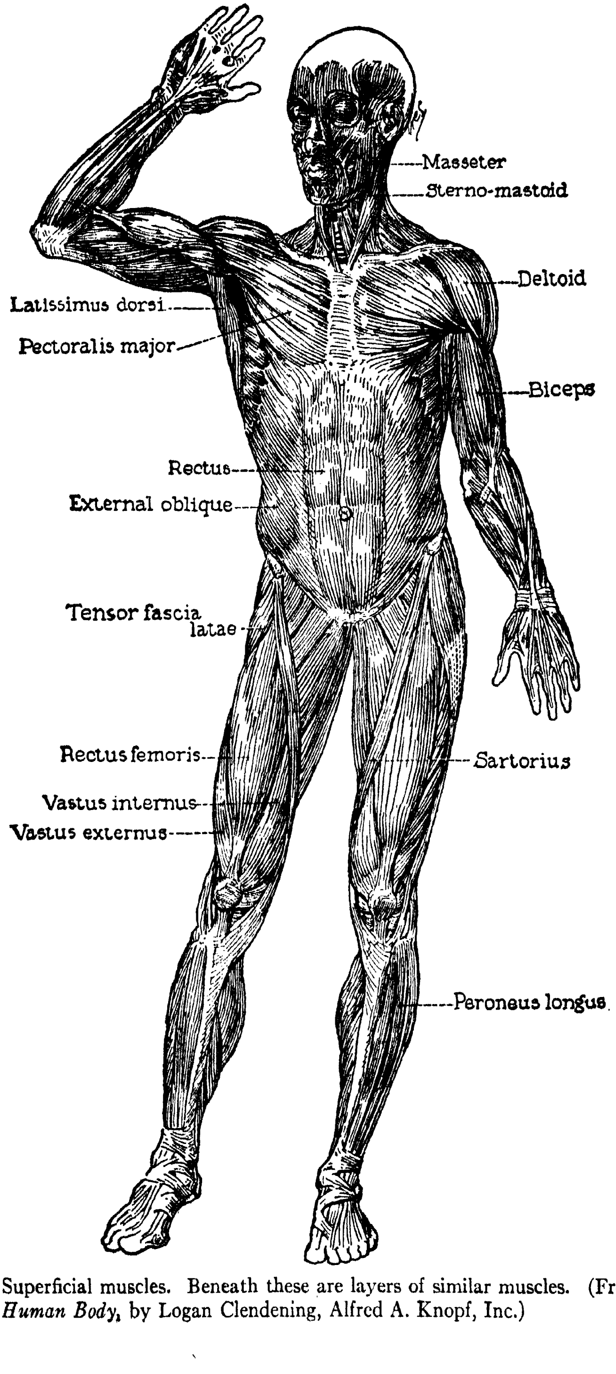
Although muscles exist primarily for movement, they also give the body its smooth roundness. The type of muscular development has much to do with the external appearance. Animals differ in appearance partly because of their bony framework and partly because of the type of muscular development. Strong muscles are essential for draft work, but lithe, flexible ones make for speed. And who can say that the speedy riding pony is more *beautiful* than the sleek draft horse or that the powerful Clydesdale is more *useful* than the swift Arabian?

Similar differences exist among human beings. You may be blest with the draft type of muscles or with the racing type. You should not attempt to change your type but develop and use them with the greatest possible strength and grace for your particular work, whether it be typing, playing a musical instrument, or building roads.

Before reading further, turn back to Problem 2 and reread page 37.

General arrangement of skeletal muscles. The external muscles are called the *skeletal* muscles because they are attached to the skeleton and move it. Just below the skin are the *superficial* or outer layers of muscles. These are shown in Fig. 81. To most people the names of the muscles are of little practical value, hence only a few of the more common ones will be mentioned here.

The *biceps* muscle, in front of the upper arm, is of great interest to growing boys. Can you see and feel your biceps when you bend your elbow? The *triceps* is its mate on the opposite side of the arm.



81 Superficial muscles. Beneath these are layers of similar muscles. (From *The Human Body*, by Logan Clendening, Alfred A. Knopf, Inc.)

It is used to straighten out the elbow after the biceps has flexed it. Which of this pair delivers the "punch" in striking a blow?

The *deltoid* is a large triangular (delta-shaped) muscle on top of the shoulder that lifts the whole arm, while the *latissimus* ("broadest") muscle pulls the arm down and back. Can you find these on the diagram and locate them in your own body?

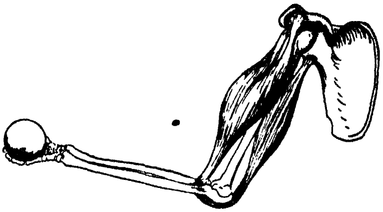
Beneath the superficial muscles there are layers of similar ones called the *deep* muscles. For instance, in the forearm are three layers, or a total of 20 distinct muscles. Some of these move one finger at a time, some clench the fist, and others move the wrist. Similar groupings of muscles are found in all parts of the body.

Paired arrangement of muscles. To understand the remarkably graceful and efficient arrangement of muscles, try a simple experiment. Observe closely. Clench your fist tightly and examine your arm just below the elbow. Are the muscles hard in the front part of the arm or the back part? Now straighten the fingers out stiff. Which part of the arm is hard and tense now? Which muscles are soft? (If a muscle is hard, it is contracted and pulling or working; if soft, it is relaxed.)

Very slowly pull one finger down hard and straighten it out stiff again. Can you determine which muscle pulls it down and which extends it? These sets of muscles are typical of many in the body. Those that bend or flex a part are called *flexors*. Where are the flexors that bend the knee (Fig. 81)? Muscles that extend or straighten a part are called *extensors*. Where are the extensors that straighten the leg? Is the biceps of the arm a flexor or extensor?

These examples illustrate the *basic principles* governing the action of all skeletal muscles, namely: (1) each muscle can *pull* only; it never pushes; therefore, (2) almost all muscles are arranged in *pairs*, one to pull a bone one way and another to move it back again. Two such muscles are said to be *antagonists*. (3) When one muscle of a pair becomes tense (contracts), the opposite one is supposed to relax proportionately.

When a pair of muscles act in harmony, alternately contracting and relaxing, the movement is graceful, without jerks or awkwardness. The best runner uses the least energy, for he knows how to relax and contract his muscles in the most efficient rhythm. The amateur in learning a new movement of any kind is inclined to tense too many muscles, thus making the antagonistic ones work against each other. Hence, when learning to play a new game, take it more easily and you will become skilled much more quickly.



82 To bend your arm, the biceps contracts — grows shorter and thicker — and the triceps relaxes. What happens when these muscles reverse their actions?

How muscles are attached to bones. Muscles are usually attached to bones by means of *tendons*. A tendon is made of extremely tough, white, inelastic material. Tendons are sometimes flat, but usually round, like those you can see and feel in the "Achilles[1] cord" just above the heel. Sometimes tendons are bound into place by *ligaments*. Note the annular ligaments at the wrists and ankles (Fig. 81).

How muscles make bones move. A muscle cannot move a bone unless it is firmly fixed to another bone which does *not* move. For example, the foothold for the biceps is the shoulder blade, to which it is attached by two tendons (Fig. 82). The opposite end of the biceps is attached to the "radius" bone of the forearm about an inch and a half below the elbow joint.

When a muscle contracts, the center part becomes harder, thicker, and shorter, exerting a powerful pull on the two extremities. Note in Fig. 82 that the mechanical construction enables the hand to move through a long arc while the muscle contracts only a short distance. If the muscle were attached farther from the hinge, would it have to shorten more or less in order to raise the hand the same distance?

Other muscles, such as those in the neck, are attached farther from the pivot, or center of action, hence they produce slower motion, but have to pull less. Consequently they do not tire so easily from the work of holding up your head. Many other muscles, such as those in the hips, are constructed to exert great force with little effort. If you were to study carefully the detailed arrangement of all muscles in the body, you would marvel at the manner in which each bit of structure fulfills the exact need in the particular spot where it is located.

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[1] Named from the story of Achilles.

Microscopic structure of a skeletal muscle. Skeletal muscle cells are quite different from any other cells in the body. Although they are from $\frac{1}{25}$ inch to $1\frac{1}{2}$ inches long, you cannot see them without a microscope because they are only about $\frac{1}{2500}$ to $\frac{1}{250}$ of an inch in width. Parts of four muscle cells or *fibers*, as they are called, are shown in Fig. 83. In order to show their length in proper proportion to the width, it would be necessary to make the diagram from 8 to 15 feet long.

Each cell is enclosed in a thin transparent membrane called the *sarcolemma* (sär′kō-lĕm′ȧ). To this are attached fine fibers of connective tissue which combine with the fibers from the other cells of the muscle to form its tendons (Fig. 83). Through its own connective fibers each cell exerts its pull on the tendons. Of course, the meat of the muscle nearest the tendon contains more connective tissue and is tougher than the central portion.

Under very high magnification each cell shows many nuclei and gives the appearance of fine marks across the cell. Because of the striped effect, skeletal muscles are also called *striped* or *striated* muscles.

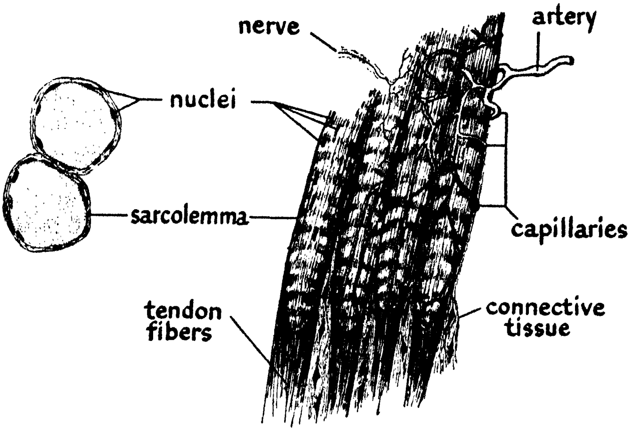
Gross structure of a muscle. Groups of fibers are bound together in small bundles about the size of the lead in a pencil, and are wrapped in connective tissue which extends from tendon to tendon. These bundles, called fasciculi (fă-sĭk′ū-lī), are responsible for the stringy appearance of a pot roast. Small fasciculi are grouped together into larger ones, and these are bound together to make up the whole muscle. More or less fat is deposited between the sheets of strong, tough connective tissue which surround the muscle groups.

A muscle's blood and nerve supply. Capillaries and nerve fibers enter the connective tissue and send branches to the muscle cells, as shown in Fig. 83. The blood stream must furnish a large supply of oxygen and sugar for the working muscle, and must constantly cleanse it of wastes.

A muscle without a nerve supply is as "dead" as an automobile engine without a battery. *No skeletal muscle ever contracts without a nerve impulse to set it off.* In fact, if the nerve to a muscle is cut or destroyed, the muscle becomes paralyzed. Nerves also guide the muscles and make them work together, or *co-ordinate*

(Fig. 84). Efficient muscle activity depends upon an active, clean blood stream and well-controlled, healthy nerves.

The story of how a muscle contracts. Let us turn our mental movie camera down to extremely slow motion on a muscle cell. The muscle, as a whole, is at rest, but the cell is busy preparing for its next activity by taking in a supply of oxygen and sugar. The cell instantly converts the sugar into another form, glycogen, and stores it within itself. Just what other chemical changes it makes in the sugar is not known, but it is probable that it converts at least part of it into a much less stable form ready for instant ignition. This may be compared to dynamite that is ready to be touched off. It is impossible to determine directly the nature of such a substance, because as soon as the muscle is touched or in any way stimulated, this chemical compound is instantly changed into lactic acid.



83 Parts of four skeletal-muscle cells. Though each cell has hundreds of nuclei, only a few of these are indicated on the cell at the left. You see the ends of the cells. Note the attachment of the sarcolemma to the tendon fibers. Nerve fibers (one is shown) also thread between the muscle cells to stimulate and guide their action. Why are the capillaries important?

Experiments show that a muscle can store enough fuel to work for many minutes without refueling, *i.e.*, without a fresh blood supply. When the cell has stored its fuel, it rests. If it belongs to a healthy, active individual, it does not relax completely but maintains a slight degree of contraction called *tone.* A muscle in tone does not have to waste time taking up the slack, but is ready for instant action.

Flash! comes a command from the brain via the nerves and immediately all is action. Instantly the unstable sugar is split into lactic acid [1] and water, and the cell becomes thicker and shorter. It does not really grow larger but only *changes its shape.* Remember that *muscles work only by shortening.*

As soon as a cell has contracted, it starts preparing for the next action. First it must rid itself of the lactic acid. The almost instantaneous disappearance of this substance from the cell under normal conditions is one of the marvels of physiology. More marvelous yet is the fact that it is not all swept away as is the exhaust from an automobile cylinder, but a large portion of it is *reconverted into glycogen to be used again!* Think of it! Suppose someone should invent a gadget that would fit the exhaust pipe of an automobile and change the exhaust gases back into gasoline. That's exactly what your muscles will do if you will but supply them with one thing — enough *oxygen.* And that's free for the taking.

The "oxygen debt." When you run at top speed your muscles work so fast that the lungs and blood stream cannot supply all the oxygen needed. The muscles continue to work, however, going into "debt" for oxygen for recovery. You become more and more out of breath, and even after the exercise is over you will continue to "pant" for a long time. Athletes sometimes require an hour to pay off the oxygen debt acquired by their muscles in running a hundred-yard dash. *Breathlessness is one of the first warnings that exercise has been carried far enough.* This acts as a protective device to save the cells from complete exhaustion and injury. You cannot afford to disregard this signal.

What graceful motion really is. Whenever a single muscle fiber or cell is stimulated, it snaps into complete contraction. No halfway action is possible. The fiber either pulls its best or not at all. After it contracts, it immediately begins to relax, and recovers normally within a few seconds. Although each single cell contracts suddenly and then relaxes immediately, all the fibers of a muscle do not ordinarily contract at the same time. Recall some experience when you tried to do something that required more strength than

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[1] This is similar to, but not exactly the same as, the lactic acid of sour milk.

84 The mystery of co-ordination. A typist trains her muscles to co-ordinate so that she strikes the right key at the right time and with the proper strength — and all according to what she sees! (Courtesy of Los Angeles Board of Education)

you seemed to have — then with a series of determined efforts, without relaxing or "letting go" in between, you found that you gradually increased your strength. In cases like this you apparently stimulate more and more fibers. When you have learned to stimulate as few or as many fibers as are needed, you have become skillful in the use of your muscles. You say you have learned to *co-ordinate*, *i.e.*, to make your muscles work together well.

Graceful movement appears to depend upon stimulating one set of fibers after another in smooth rhythm, with the least possible expenditure of energy to accomplish the desired action. You may learn to do this by practicing slow, regular movements. The clumsiest boy can develop a light step if he wishes. The most awkward girl can practice graceful movements until she does them without any conscious effort. Youth is the time for such training. A little effort pays large life dividends to both boys and girls in attractiveness, bodily control, and self-esteem.

Muscular tension is continuous work. The muscles that hold you upright in sitting and standing often work continuously without any complete relaxation for hours or even all day. Not all the cells pull constantly, however, for while some are working, others are refueling. Different fibers take up the work in such rapid suc-

85 It's fun to acquire gracefulness and bodily control. (Courtesy of Los Angeles Board of Education)

cession that the muscle as a whole never relaxes. When the nervous system is sending impulses to a muscle too rapidly for it to show any relaxation between contractions, as when it is exerting a steady pull, the muscle is said to be in a state of *tetanus*. This same name is also applied to the disease called "lockjaw," one symptom of which is muscle spasms, particularly of the jaw muscles.

HOW OTHER MUSCLES COMPARE WITH SKELETAL MUSCLES

Your whole body is teeming with *activity* of which you are not even aware and over which you have no direct control. Blood races through your veins, you breathe automatically, and your food is churned and pushed along. These movements are much more vital to your existence than are the more spectacular movements of the skeletal muscles. Without skeletal movements you would be helpless, but without movements of the internal organs you would soon die.

Kinds of muscles in the body. Practically all[1] body motions are brought about by one of the following three types of muscles: (1) skeletal muscle, (2) smooth muscle, and (3) cardiac muscle. Although they are not directly connected, their activity is remarkably co-ordinated, as you will learn in Problem 18.

The nature of smooth muscle. The muscle cells in the internal organs are spindle-shaped and contain only one nucleus, as shown in Fig. 8–I. They form *smooth*, thin sheets of tissue which cover all hollow organs such as the stomach, intestines, blood vessels, and urinary organs. They are also found in certain special muscles such as those of the eye, and those attached to hair follicles.

Smooth-muscle contractions reduce the diameter of an organ and squeeze and push along its contents as in peristalsis and blood circulation. Compared to the lightning-speed action and rapid fatigue of skeletal muscles, smooth-muscle contractions are very sluggish and may be prolonged almost indefinitely. It is extremely important that smooth muscles be in good tone, particularly in the blood vessel walls.

Smooth muscle is also called *involuntary* muscle because it is controlled by the autonomic nervous system (page 35) without your knowledge or conscious direction. For example, you cannot willfully start or stop peristaltic action. Nevertheless it is affected indirectly by your thoughts and emotions. If you become greatly frightened when the digestive organs are at work, the smooth muscles relax and peristaltic action ceases almost instantly.

The double inheritance of cardiac muscle. In both structure and action, cardiac, or heart-muscle, cells are intermediary between the skeletal and smooth muscles. They resemble skeletal muscles in that they are faintly striated, and smooth muscles in that they have a single nucleus and are able to maintain their tone without any nerve connections whatever. Their blocklike structure makes them very strong (Fig. 8J). The distinguishing characteristic of heart cells is their end-to-end arrangement which helps them work together in harmony and rhythm. Cardiac muscle contracts more swiftly than does smooth muscle, but not so swiftly as skeletal muscle. Other properties of this remarkable tissue have been treated in the discussion of the heart.

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[1] Exceptions, or movements *not* caused by muscles are: the flowing of protoplasm within the cells; the oarlike action of cilia in the windpipe and other organs; and the amebalike movement of white corpuscles.

HOW TO MAKE YOUR MUSCLES WORK WITH LEAST FATIGUE

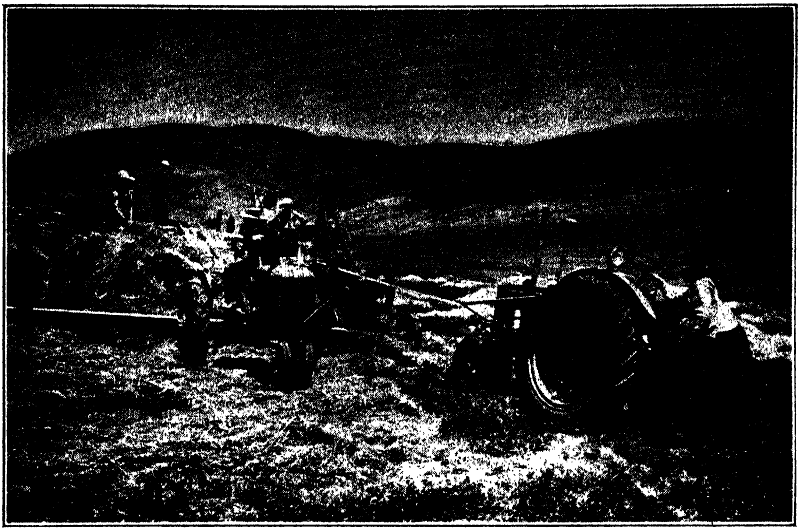
Everybody wants to accomplish the most with the least possible effort and fatigue. In other words, we want to be "efficient." Efficiency has many elements, but for the present let us investigate the easiest way to get the most done with our muscles.

Good circulation helps prevent fatigue. Experiments show that the time necessary for a tired muscle to become rested depends on its circulation. After a period of work, a muscle *deprived of circulation recovers slowly and incompletely*, whereas one with circulation intact recovers much more rapidly and eventually returns to its original power. Resting not only gives the blood a chance to bring fuel and oxygen to the muscle but also helps it get rid of the waste products, principally lactic acid.

Experimental facts lead to the conclusion that it is mainly the accumulation of lactic acid and carbon dioxide in a muscle that tires it. They are like the ashes and clinkers that clog a stove so it won't burn well, or the carbon deposit in the cylinders of an automobile that interferes with its performance. To prevent muscle fatigue, its wastes must be carried away and eliminated from the body rapidly.

Fresh air versus fatigue. Deep breathing is the chief enemy of fatigue because it removes the carbon dioxide directly and the lactic acid indirectly. Part of the lactic acid (about one fifth) is *oxidized* into carbon dioxide and water and the rest changed back into glycogen. This process requires an abundance of oxygen. If the oxidation cannot take place as fast as the lactic acid is formed, the acid accumulates and causes fatigue.

The more oxygen is supplied to the muscles while they are working the better and longer can they work and the less "oxygen debt" will they pile up. For example, you do not tire so easily when working or playing out of doors or in well-ventilated rooms. Also, trained athletes have great endurance chiefly because they have trained their lungs and their hearts to work more efficiently.



86 Farmers can work hard for long hours without undue exhaustion because their work stimulates circulation, perspiration, and deep breathing of fresh air, all of which helps rid their bodies constantly of fatigue wastes and promotes muscular efficiency. (Courtesy of J. I. Case Company)

Skilled muscles are necessary for speed, but a strong and well-used breathing apparatus and heart are absolutely essential for endurance.

Loss of muscle fuel as a cause of fatigue. If a muscle is worked long enough without its fuel supply being replenished, it will eventually become exhausted even though no wastes are allowed to accumulate. Marathon runners probably suffer from this type of fatigue, for tests of their blood when they are near collapse show it to have an unusually low sugar content. Eating sugar in some form definitely helps them to recover from their profound fatigue. Lack of fuel, however, is not often the cause of fatigue, for muscles usually become low in oxygen or clogged with wastes long before their fuel supply runs low.

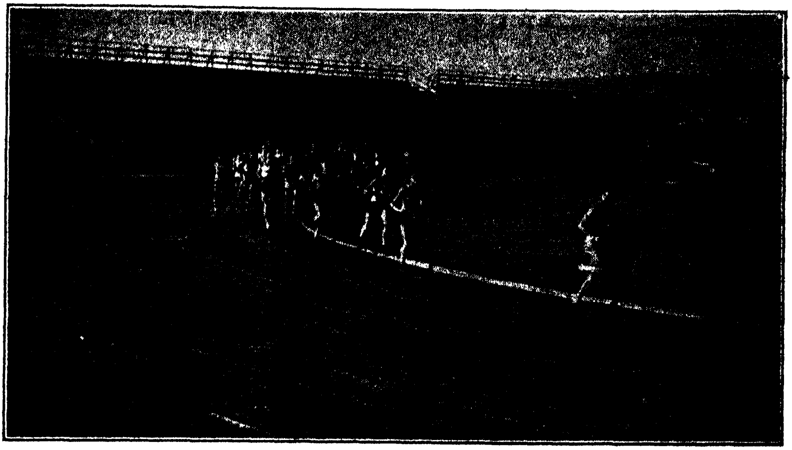
How rest helps muscular efficiency. Throughout the day your muscles gradually become fatigued from all three causes — loss of fuel, need of oxygen, and collected excess wastes. The blood and muscles may be restored to normal by resting for at least 8 hours. It is better to sleep, although this is not necessary so far as the muscles alone are concerned, provided you *lie quietly*, *relax*, and *breathe deeply.*

Frequent short rest periods have been proved to be of astonishing value in increasing efficiency. The output of riveters has been increased from 600 to 1,600 rivets daily per man by enforced rest of 2 minutes after each 10 rivets. Employers are learning that they can really get more work out of their employees by giving them frequent rest periods, letting them sit at their work whenever possible instead of standing, and providing every means possible for saving their energy and preventing fatigue. Some shops even furnish couches where workers may relax completely for short rest periods.

Make your own application of this principle. If you cannot lie down for 5 minutes out of each hour, you can at least stop whatever you are doing, stretch, take a few deep breaths, walk around, run in place a little, or go outside in the sunshine for a few minutes. Then consciously relax as much as possible even though you may have to stand up while doing it. By resting oftener you'll get more work done in the end.

How hurry increases fatigue. Experiments show that anyone with healthy blood and good circulation can tap a telegraph key for an indefinitely long time without fatigue if he presses it only once every 10 seconds. At that rate the cells recover between contractions and the muscles never become tired. At high speed the degree of fatigue sky-rockets out of proportion to the amount of work accomplished, and the muscles soon become unable to work until they have rested. When you begin to hurry unduly, remember that the tortoise beat the hare because he took his time and kept going.

The rate of one contraction in 10 seconds is too slow to be practical; but if you could plan your work and make rushing unnecessary, you would be able to keep going much longer and in the end accomplish more. You need to pace yourself according to the task ahead, just as athletes do in racing (Fig. 87). The great Nurmi carried a stop watch to keep himself from running too fast until the final sprint. You, too, can conserve and distribute your strength so as not to be fagged out at the end of the day or school year, if you follow nature's law of moderation in all things.



87 Who will be the winner? This is the first lap of a long-distance race. Wise runners know their least-fatiguing pace. The winner of this race held fifth place for the first four laps.

Rhythm versus fatigue. Rhythm is a great aid to effective, nonfatiguing, and graceful muscular action. When a muscle contracts and relaxes at regular intervals, fresh blood surges through it in constant succession and keeps the muscle fed, clean, and rested. Indeed, the relaxation phase of any exercise is most important. Standing still is more fatiguing than walking because in walking each muscle is relaxed half of the time. To relieve the tension of muscles used in sitting or standing, it is well to move around, to bend over, to stretch or lie down occasionally.

Probably the best scheme for keeping muscles working in rhythm is the use of music. It is said that Jack Dempsey used to hum to himself while fighting, for this kept all his muscles working together best and his punch had more power behind it. Singing at your work, if it doesn't interfere with others, makes your task lighter, because it helps prevent the accumulation of fatigue wastes. Learning to type to music develops the habit of working rhythmically and produces better work with less fatigue.

Why "warm up" your muscles? Muscles work best at about normal body temperature, 98.6° F. Just as skin temperature may vary a few degrees from this, so may that of the superficial muscles. When muscles are slightly cooled, they do not respond as quickly or as strongly as when warm. Athletes have a purpose in wearing

88 Did you ever try taking the fatigue out of a job similar to this one by doing it in rhythm, through singing or counting?

sweat suits and lying in the sun while waiting to be called into action.

Getting muscles warm and ready to respond is only a part of the reason for "warming-up" exercises. This practice also accelerates the breathing and circulatory mechanisms to correspond with the muscle speed. It is dangerous to the heart muscle and fatiguing to the skeletal muscles to attempt hard exercise too suddenly.

Muscular strains and other injuries. Sometimes, under extreme stimulation, muscles will work even though greatly fatigued. The present theory is that they are strained because they have used all their reserve fuel and are then forced to use some of their own protein material so that some cells and connective tissues are themselves torn down. A strained muscle may recover from the pain in a few days but may require a long time to regain its original strength.

Mild soreness after unusual or continued exercise may not reach the point of actual strain but may be due merely to accumulated wastes.

A muscle *cramp* is a strain in which the muscle is thrown into a spasm and cannot relax. This may be caused by prolonged contraction, by cold, as in swimming, by a lack of oxygen supply to the muscle, or by using the muscle in an unnatural position so that its circulation is impaired.

The treatment for all these conditions is to remove the primary cause and to stimulate circulation. Straighten the limbs and massage the muscles — in the direction *toward* the heart. Relieve simple soreness of muscles by a warm bath. Some liniments may be useful in helping to stimulate circulation, but in most cases it is the rubbing more than the liniment that produces any desirable result.

A bruise usually results from a blow that crushes the muscle against a bone. Such a bruise occurs frequently in football and often requires several weeks to heal. The application of hot-water compresses increases the blood supply to the region and gives the injured cells a better chance for quick recovery. Protective pads help prevent such injuries.

A still more serious injury — a *strained tendon* — occurs where the latter is attached to the bone. Since a tendon has only scattered cells and few blood vessels (Fig. 8F), it heals much more slowly than a tissue composed mostly of cells that do repair work. A strained tendon should be treated with heat and massage and allowed to rest at first; then its use may be gradually increased.

THE KIND OF EXERCISE YOU SHOULD HAVE

Life *is* activity — lack of one means lack of the other. One serious result of present-day living is that automobiles and labor-saving devices perform too much of the physical activity needed to strengthen heart, lungs, and muscles.

How general exercise benefits the whole body. If any two effects of general exercise are more important than others, they are (1) the *ventilation of the lungs*,[1] and (2) the *strengthening of the heart*.[2] *A physician should prescribe appropriate exercise for persons with weak hearts* in order to avoid the possibility of overexertion. Normal hearts, however, are weakened by *lack* of exercise.

Other benefits from exercise are (3) *increased perspiration*, which cleans the pores and trains the heat-regulating mechanism; (4) *increased circulation*, which flushes out any congested capillaries all over the body, especially in the internal organs, and brings the cells an abundance of food and oxygen needed for good nutrition; (5) *increased oxidation of fuel,* which stimulates the appetite directly and the digestion of food indirectly; (6) *development of skeletal and visceral muscles;* (7) *training in co-ordination of mind and body,* which enables one to use his muscles skillfully and gracefully; (8) *stimulation of growth,* if exercise is not too strenuous[1]: and (9) *exhilaration of the mind,* which helps one to forget his troubles and to keep a cheerful outlook on life.

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[1] Exercise stimulates breathing by (1) increased carbon dioxide content of the blood, (2) nerve reflexes from muscles and joints, and (3) direct nerve stimuli to the respiratory center.

[2] Exercise of the skeletal muscles stimulates heart action by means of (1) increased carbon dioxide content of the blood, (2) adrenalin, secreted when the oxygen supply is decreased, (3) squeezing action of both the muscles and the breathing mechanism on the blood vessels which increases the return of blood to the heart, (4) nerve reflexes from the muscles and joints, and (5) direct nerve stimuli through the accelerator

What constitutes suitable types of activity? In order to gain all the foregoing benefits, choose activities to suit your own likes and needs. Each person will have to decide for himself just how vigorously and long he should exercise. Anyone whose health is impaired should have his physician prescribe the type and amount of activity. For those in normal health, the following rules will help in selecting suitable activities:

1. The activity should *be brisk* and *strenuous* enough to stimulate faster breathing and increased heart rate. Clothing must not interfere with full respiration and easy movement.

2. The activity should *never be exhausting.* A pounding heart, extreme breathlessness, and excessive perspiration should be avoided. If these warning signals appear, stop immediately. It is a serious mistake to attempt to keep up with the other fellow when the effort involves overstrain. For this mistake many have suffered throughout the rest of their lives. Track, basketball, and football furnish special temptations to excessive activities. No one should participate in any vigorous sport without a doctor's approval and no one should feel ashamed to take time out for rest while participating in strenuous activities. The person who rests *before he has to* is really wise.

Girls in particular must conquer their false pride and face the fact that in physical strength they are not equal to boys and should not attempt to compete with them in body-contact activities such as football, basketball, and hockey. It is highly desirable, however, that boys and girls learn to participate together in many of the lighter individual and dual activities such as tennis, badminton,

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[1] Experience indicates that moderate muscular activity is essential, but overindulgence, especially in high-school sports, depletes vitality and retards growth.

89 Everyone needs natural outdoor exercise. Most people can get it in their own back yards or a neighborhood vacant lot. Expensive equipment is not necessary. What other "back-yard sports" can you suggest?

archery, swimming, ping pong, horseshoes, bowling, golf, skating, dancing, and possibly volleyball and softball.

Certain sports are condemned for girls, namely, broad jump, high jump (in competition), pole vault, weight throwing, and running more than 100 yards in competition.

3. The activity should *use many muscles.* The best activities are those which involve many types of movements. Walking, running, swimming, rowing, and team games are especially good.

4. The activity should *be out of doors* if possible. If not, good ventilation should be provided.

5. The activity should *suit the type of individual.* Nervous, high-strung people should participate in fairly slow, methodical activities such as walking, running, swimming, or horseback riding. They should be as relaxed and easy about it as possible. The slow, phlegmatic type of person needs stimulating games like handball, volley ball, or tennis.

6. The activity should be *enjoyable.* The best exercise involves the play spirit, which takes the attention from oneself. Active sports participation with good companions is invaluable in developing one socially as well as physically. It pays to give sufficient time and effort to become proficient in several sports. It is a good plan to have some hobby that includes vigorous exercise. Combine exercise with other duties; walk instead of using autos, street cars, and elevators; make a game out of housework and gardening; or even do systematic setting-up exercises if nothing better can be devised.

Conclusion. Since proper *exercise* is necessary for good circulation and good muscle tone, and since these are essential to the health of every organ of your body, you cannot afford to neglect this vitally essential part of your daily program.

You will accomplish more in less time and with less fatigue if you work rhythmically, work at a fair pace without undue hurry, maintain good posture, get plenty of fresh air constantly, and take frequent short rest periods.

ACTIVITIES

1. Self-check on your study of this problem. See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. Study of the general structure of muscle. Use a piece of lean beef, preferably from the shank. Note its stringy appearance. To what is this due? Note the connective tissue and the small bundles grouped into larger ones. Note how the connective tissues form a tendon, and how the tendon is attached to the bone.

3. A dissection. Use a small animal, such as a frog. Note carefully how some of the muscles are arranged, how they are attached to bone processes, and how they make the bones move. A chicken's leg with foot intact is good for this. Pull one tendon at a time and note results.

4. Study of the nature of fatigue. Time yourself accurately on how long you can tap a piano or typewriter key in an irregular fashion, fast, slowly, jerkily, etc. Use one finger only, keeping wrist and other fingers as quiet as possible. Rest at least 15 minutes and repeat the experiment, this time counting evenly and slowly and pressing the key on each count. Explain the results.

5. Overcoming awkwardness. Practice some exercise slowly and rhythmically for 15 minutes each day to develop gracefulness of motion.

6. Learning to play a new game. Learn a new game or improve yourself on an old one, applying what you have learned in this problem. Keep a record of your success and special things you may observe.

7. Key words. Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each:

- skeletal muscle
- smooth muscle
- cardiac muscle
- antagonistic muscles
- tendons
- muscle fiber
- sarcolemma
- lactic acid
- oxygen debt
- muscle tone
- warming up
- strain

8. A study of your exercise habits. Make a record of the exercise you actually get during an ordinary week. Then check yourself on the health habits below. If you find your ordinary weekly routine does not give you sufficient exercise of the proper kind, reorganize your way of living so as to get what you need. *Live* according to your revised plan for a month, checking yourself on it daily (see Problem 1, pp. 12–15).

Your Health Habits

Check yourself on the following habits. Do you —

a. Exercise daily in fresh air?
b. Exercise briskly enough to stimulate your heart and lungs?
c. Do some exercise daily that uses practically all your muscles?
d. Always "warm up" before strenuous exercise?
e. Always stop exercising before becoming too tired?
f. Work and play in good posture?
g. Enjoy your exercise, whether work or play?
h. Exercise according to your type (see page 236); if any weakness, let your doctor prescribe your exercise?

SUGGESTED REFERENCES[1]

Antrim, D. K., "Step on It to Music; industry uses the classics to drive fatigue out of work and pep up defense production," *American Magazine*, August, 1941, p. 29. (Extra good.)

Jastrow, J., "Story of Human Energies," *Hygeia*, **16** : 141–144, 238–241, February, March, 1938.

Josselyn, Daniel W., *Why Be Tired?*, Longmans, Green & Company, New York, 1936. (Excellent.)

Reed, D. B., "Exercise," *Hygeia*, vol. 16, April–December, 1938.

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[1] Use also books in *General References* in the Appendix.

Problem 14. *How Can You Keep Your Skin and Hair Healthy and Attractive?*

Increase of physical beauty is attended by increase of soul beauty. The soul is the higher even by gazing on beauty. Let me be fleshly perfect. — RICHARD JEFFRIES, *The Story of My Heart*

STUDY OUTLINE

A. The skin and its outgrowths
   1. Why does skin tan? Why do you lose a tan in winter?
   2. What makes the pattern in a fingerprint?
   3. What purpose is served by the pores of the skin?
   4. How does hair grow? Can lost hair be replaced?
   5. Why does a permanent wave make hair curly?
   6. How do fingernails grow?

B. The daily care you should give your skin
   1. How can your state of health show in your skin?
   2. What foods should you eat for a clear skin?
   3. How hot should a bath be?
   4. Should you use soap or cold cream to cleanse your face?
   5. How can you keep your hands in good condition?
   6. How and when should cosmetics be used?

C. Some special problems of skin care
   1. If your skin seems thick and not thoroughly clean, how can you give it a special cleansing?
   2. What should you do about each of the following: blackheads, pimples, acne, body odors, excess hair, warts, and moles?

D. How to keep your hair looking well
   1. For healthy hair, what is the one most important habit?
   2. What kind of shampoo is best?
   3. What can you do for dandruff?

A POOR complexion suggests disease or neglect in personal cleanliness. Frequently it is a combination of both. If you desire a good complexion and attractive hair, you cannot neglect their special care or the general health of your body.

THE SKIN AND ITS OUTGROWTHS

From experience with blisters you know that the skin peels off in layers. The outer layer is called the *epidermis;* the deeper one, the *dermis*, or true skin; and the third, the *subcutaneous* (= under the skin) tissue which attaches the skin to the parts beneath it.

How new outer skin is always forming. The *epidermis* (ĕp′ĭ-dûr′mĭs) forms a protective covering over the true skin. It is composed of (1) the outer *cuticle* (kū′tĭ-k'l) or surface of dead cells, (2) the middle *pigment layer* containing coloring matter, and (3) the inner *germinative layer* of "mother cells" capable of producing new cells (Fig. 90).

The dead, flattened, scalelike cuticle cells contain a protein substance which makes them waterpoof and protects the body from bacteria. Wherever there is constant rubbing or pressure, the cuticle increases in thickness and forms callouses or corns.

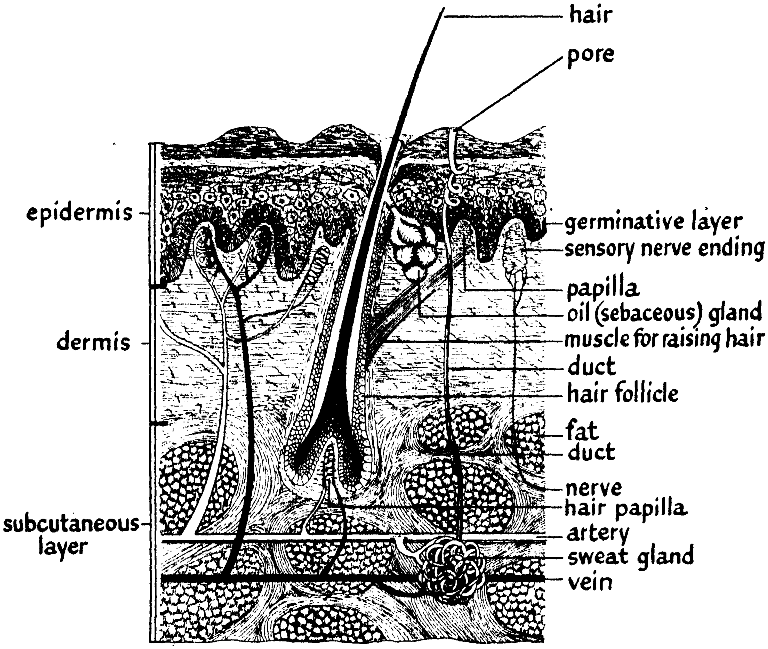
Tan is the result of a pigment which forms in the middle layer of the epidermis when sunlight penetrates the cuticle. People who have an inherited ability to tan rarely sunburn because the pigment layer protects the underlying tissue. Light-skinned persons who cannot tan have no protection against the sun and are very susceptible to sunburn. Since the top layers of skin are constantly being worn away, tan is lost during the winter by actually rubbing off the cells containing the pigment.

The nature of true skin. The true skin or *dermis* consists of a network of connective-tissue fibers, blood vessels, and nerves, together with the following structures: (1) *papillae* (pȧ-pĭl′ē), (2) *sensory-nerve endings*, (3) *sweat glands*, (4) *hairs*, (5) *oil glands*, and (6) *nails*. Let us consider each of these in detail.

Fingerprints. The ridges on the front of the fingers are rows of tiny projections called *papillae*, in which are found blood vessels. Fingerprints show that they form different patterns in different people; their patterns practically never change.

Nerve endings for feeling. Some papillae contain delicate little clumps of nerve tissue (Fig. 90). These are the nerve endings through which we receive sensations of touch, warmth, cold, and pain. They are discussed in Problem 15.

How perspiration is produced. Look at the pores on the back of your hand. Each one of them is the opening from a tiny *sweat gland*. As shown in Fig. 90, the duct from the gland extends down into the dermis or even the subcutaneous tissue where the gland itself is embedded. The gland is merely a tiny tubule coiled up into a ball and closely surrounded by a meshwork of capillaries which supply the cells of the tubule with the materials for secreting perspiration.



90 Diagram through a vertical section showing the structure of skin. Cover the list of labels and see if you can name the various parts.

Perspiration is composed of water, salts, urea, and other substances dissolved in the blood. It is secreted by the sweat glands in much the same manner that saliva is produced by the salivary glands. The chief function of sweat glands is to regulate body temperature (Problem 9); hence, normally they are stimulated to act when the blood temperature rises.

Ordinarily, perspiration evaporates as fast as secreted, but sometimes it collects in drops on the skin. When perspiration is profuse over a long period and water is drunk in large quantities, it removes too much salt from the blood and lymph. During such times the salt should be replenished by drinking a weak salt solution (0.2 per cent) instead of plain water. In hot areas many industries advise employees to drink salt water to avoid heat exhaustion.

How hair grows. With a few exceptions, the entire skin area has some growth of hair. Each hair develops from a *hair follicle* in the germinative layer of the epidermis, as shown in Fig. 90. Cells push upward from the follicle, fuse, and harden into hair. As long as the cells in the follicle remain active, a hair may be regrown; but when they die or lose their vitality, lost hair will not be replaced.

The *shaft* of a hair, above the surface, consists of three distinct layers of horny dead cells. The middle layer contains coloring matter which produces various shades according to the amount and character of the pigment. As a person grows older, the supply of pigment diminishes and the hair becomes gray. Curly and straight hairs differ only in cross section; curly hairs are flat while straight hairs are round.

Attached to the root of each hair is a tiny muscle. Ordinarily, the hairs slant downward, but when one becomes cold or frightened, these muscles contract, raising the hairs into an upright position and forming "gooseflesh." These muscles have little value to man, but they are important to animals whose hair or fur must protect them from cold. When their hairs are raised, the outer ends overlap and form a tight network.

Natural oil for skin protection. Although you may be aware of oiliness only on the nose and hair, nevertheless natural oil, called *sebum* (sē′bŭm), forms a thin protective layer over the entire body and prevents excessive absorption or evaporation of water. Sebum is secreted by *oil* or *sebaceous* (sê-bā′shŭs) glands.

How nails grow. The development of nails is similar to that of hairs. In fact, you can think of a nail as many hairs fused together in a horny plate. The part underneath the nail to which it adheres is called the *nail bed.* This is composed of rows of *papillae,* tiny projections of scale-forming cells from the germinative layer of the epidermis. The bed is nourished by many tiny blood vessels which give the nail its pink color. Nails grow in length by the addition of cells from the root. Newly formed cells push the nail forward. If a nail is torn off, a new one will grow, provided the cells of the root and bed are not completely destroyed.

THE DAILY CARE YOU SHOULD GIVE YOUR SKIN

Because of individual differences, there can be no single formula for the care of all skins. Each individual must first understand the principles involved, and then experiment a little to find the treatment that is most satisfactory for his type of skin.

Why attention to health comes first. The color, texture, and quality of your skin quickly reflect your physical condition. Poisoning from the digestive tract, or from parts of the body that are diseased, frequently produces skin trouble. Proper daily elimination of wastes and the removal of foci of infection, such as diseased tonsils, are extremely important to the health of the skin.

Diet also plays an important part. Many persons should eat only a minimum of sweets, starches, and rich fatty foods in order to maintain a good complexion. This is especially true during the adolescent age, at which time the skin is unusually subject to eruptions because of rapid glandular changes in the body. The diet should include an abundance of raw vegetables, fresh fruits, and all vitamins, especially A, B, and C.

The skin is dependent upon the blood for its food supply, hence poor circulation prevents adequate nourishment. Turn to Fig. 90 and explain why cold cream cannot reach the living cells, hence cannot possibly feed the skin. Such creams are helpful in avoiding harsh, dry skin, but a good circulation is the one essential for proper nutrition.

How to cleanse and stimulate the skin. Regardless of type, every skin, in order to be attractive, must be kept clean. Skin is not clean unless the insides of the sweat and oil glands are free from dirt and waste secretions. When these ducts become clogged, the skin soon suffers.

Warm baths. The average person needs two or more warm, cleansing baths a week. The bath should be about body temperature. Avoid hot baths as they lower the blood pressure and are weakening.

To profit most by the relaxing effect of a warm bath, take it just before retiring. When taken at other times, follow it with a dash of cold water over the back and chest and a brisk rubdown, to close the pores and prevent congestion of blood in the skin.

Cold showers should be taken *only* by people who react well and feel warm and exhilarated by them. A cold shower trains the skin to respond quickly to temperature changes, and probably makes one less susceptible to colds. It increases the circulation and stimulates the respiratory, nervous, and muscular systems. It is best to begin taking cold showers in the summer. They should always be taken in a warm room and be followed by a vigorous rubdown with a coarse towel. *If a cold shower causes a person to feel cold and shivery afterward, it probably does more harm than good.*

Sun bathing has been a fad since the discovery that ergosterol[1] in the body is changed to vitamin D when the bare skin is exposed to the ultraviolet rays of sunlight. Sun bathing can easily be overdone, however, for a deep tan actually prevents benefits from the sun because the ultraviolet rays cannot penetrate it and reach the blood and living cells beneath.

The scientific method of sun bathing is to expose oneself for a few minutes the first day and to increase the time gradually until it is possible to remain in the sun for one half or one hour without reddening the skin. Then a daily sun bath of an hour or *less* followed by a warm shower, a cold rinse, and a good rubdown is highly beneficial. Sunlight not only produces vitamin D, but it also kills bacteria and thus helps heal and prevent pimples and boils.

How to care for the face. In addition to wanting it to be as attractive as possible, there are two reasons why you should give your face special attention: (1) oil and sweat glands are more plentiful in the face than elsewhere, and (2) the face is constantly exposed to dust and other foreign particles in the air.

The night routine. Use a mild soap or a good cleansing cream,[2] or both. It is better to use soap on an oily skin and cleansing cream on a dry skin.

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[1] An oily substance found in the blood and living cells.

[2] Cleansing cream is really lyeless soap, and is not drying to the skin.

91 You need not carry the shop with you on your hands and face! Make a habit of washing thoroughly before you leave.

When using soap, first wring the wash cloth out of moderately hot water and hold it against your face. Repeat until the pores are open and the circulation increased. Then make a good lather on the wash cloth and start rubbing the face gently but firmly so as to clean the pores and exercise the underlying muscles without irritating the surface.

Rinse with fresh warm water, as unremoved soap may cause the skin to become dry, rough, or irritated. To finish, rinse in cold (not iced) water and dry thoroughly. If possible, apply a little witch hazel to close the pores.

When using cleansing cream, allow cream to remain on the skin long enough to penetrate the pores. Then apply a hot wash cloth to stimulate the circulation before wiping it off. Follow by the same thorough washing and rinsing described above. If the skin is dry, finish with a little tissue cream instead of witch hazel. Tender skins that are oily frequently respond best to cleansing first with cream and then with soap and water.

The morning routine. If the skin has been well cleansed the night before, soap need not be used in the morning. An oily skin usually benefits by the use of hot water and a wash cloth, followed by a cold rinse. A dry skin may simply be bathed in cold water and patted dry with a soft towel.

Experiment in order to discover what treatment keeps your face in best condition; then, regardless of the method, do three things: (1) keep the sweat and oil glands clean to prevent blackheads and

92 The finger nails should conform to the natural shape of the finger tips. File your nails frequently. Long nails break more easily and interfere with typing, playing the piano, handling a microscope, or carrying out any other manual activity that requires skill.

pimples, (2) stimulate the circulation to bring about adequate nourishment and removal of wastes, and (3) exercise the skin and underlying muscles (by careful but vigorous rubbing with a coarse wash cloth and towel) to keep them firm and healthy.

How to care for the hands. If someone were to examine your hands and nails at this very moment, would you feel embarrassed because they are not well kept? Rough-looking hands and long, dirty finger nails are inexcusable in most cases; they mark one as being careless in his personal habits. If you are conscious of the bad appearance of your hands and try to keep them out of sight, your personality is undesirably affected and you lose poise and confidence.

It is not difficult to keep the hands in good condition. Wash them in warm water with a mild soap, *cleansing them thoroughly*, especially after handling dusty or greasy objects. Use a handbrush to clean under the nails and to stimulate the circulation. Rinse in cool water, dry carefully, and apply a soothing hand cream or lotion.[1] *The secret of soft hands lies in the application of oil, cream,*

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[1] Such creams and lotions need not be expensive. See Activity 2, page 254.

or lotion after washing. It is well to have a bottle handy wherever you frequently wash your hands.

The finger nails should conform to the natural shape of the finger tips. If they are kept moderately short, they do not break off easily. Do not use a sharp instrument to remove dirt from under the nails; brush them with soap and water and then use an orange-wood stick. If nails are discolored, wrap the stick with absorbent cotton, dip in hydrogen peroxide, and work under them.

The *cuticle* should be pushed back gently. An orange-wood stick dipped in warm olive oil is good to use for this. Cutting the cuticle will encourage it to grow back thicker and coarser. *Hangnails* should be pressed back and then cut off and an *antiseptic applied immediately. Corrugated nails,* if not caused by acidity or nervousness, may be corrected by the nightly application of hot olive oil rubbed well into the cuticle.

The soap you use. Soap that is highly satisfactory for one skin may irritate another. Try several good kinds, then stick to the one that cleanses your skin best and causes no irritation. The price and advertisements of soap are not reliable indications of its purity. Many of the less expensive soaps are actually superior to those costing a great deal more. If you want to know how the popular brands of soap compare in quality, you may get this information in publications of the Consumers' Research [1] or the Consumers' Union of the United States.[2] Pure white Castile soap is highly recommended. To get the best, ask for "Castile soap U.S.P." (United States Pharmacopeia), for there are many inferior grades on the market.

The use of cosmetics. The skin of young women and girls should not require much makeup. A little powder and a touch of color sometimes make a girl prettier, but it is a mistake for anyone to cover up her own natural coloring. The art of putting on makeup lies in applying it in such a way that other people are not conscious of its use. Those who use makeup properly make themselves *attractive,* but others make themselves *attractions.* The latter use of makeup is not only unbecoming but marks the user as careless or lacking in refinement and good taste.

The use of makeup should not cause any ill effects if the prepara-

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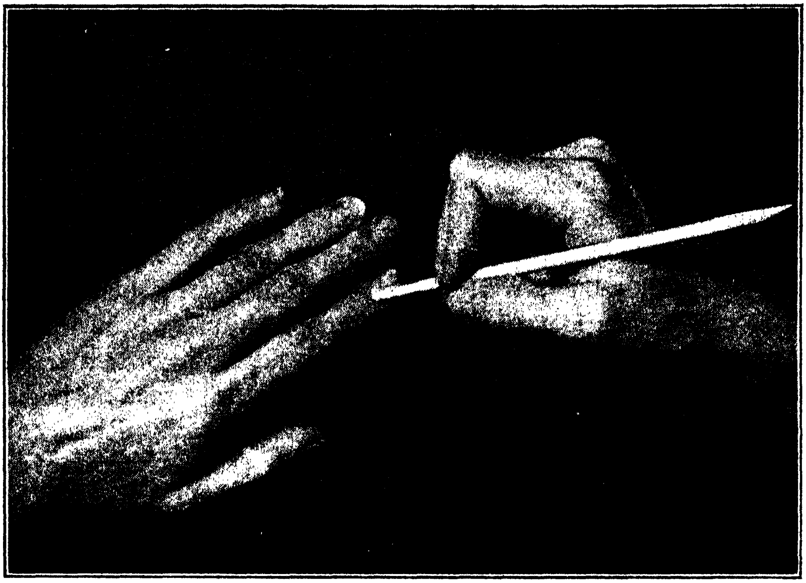
[1] Washington, N. J. [2] 22 East 17th Street, New York, N. Y.



93 The cuticle should be pushed back gently with an orange-wood stick dipped in warm olive oil. Without clean, well-cared-for hands cosmetics make you appear to be a sham.

tions do not contain injurious ingredients. Standard brands of all kinds of makeup are rated in the publications mentioned on page 248 in connection with the purchase of bath soap.

Women are very gullible in believing advertisements of products to make them beautiful. References to rare oils, vitamins, and hormones or gland extracts in certain high-priced preparations fool the public into paying exorbitant prices for them. Most of these products cost the producers but a few cents and have little or no power to accomplish any of the things claimed for them.

SOME SPECIAL PROBLEMS OF SKIN CARE

Beyond the general principles set forth in the preceding section, not much is known scientifically about the treatment of blemishes. Authorities vary widely in their opinions. Possibly this is because individual skins differ so greatly and each case seems to require its own special treatment. A few procedures, however, are known to be harmless and, in most cases, helpful. They are suggested briefly in the following paragraphs. You will be safe in trying them.

For an occasional, extra thorough cleansing (*not for tender skins*). Dampen the face and neck with warm water, rub in olive oil, then lemon juice. Massage in upward rotary motion. Continue to apply lemon juice and to massage until surface wastes no longer peel off. Rinse, then pat in a little night cream.

Blackheads. Unless pores are kept open and clean, they become clogged with sebum, wastes, and dirt which form blackheads. This condition is inexcusable, for thorough cleansing is all that is necessary to prevent it. When once developed, persistent treatment will cure it. Steam the face with hot towels to open the pores. Cleanse thoroughly with a wash cloth and good soap. Rinse, and follow with a good antiseptic or astringent. This is important to sterilize and close the pores. Pat on a soothing lotion. Repeat every few days. Soon the pores will begin to discharge the wastes themselves, and they will become smaller.

Pimples. These little pustules are caused by bacteria in the pores when the skin's resistance is low. If the pimple's contents are allowed to spread over the skin, other pores may become diseased. Therefore it is extremely important not to spread pimples by careless treatment. *Keep the hands away from them.* After thoroughly cleansing the face, as for blackheads, always swab each pimple (or spot where it may have broken and the contents have come out while washing) with an antiseptic. (If you have many pimples, read the next paragraph.)

Acne (chronic pimples). This distressing condition often occurs during adolescence when the body is undergoing rapid changes and the skin is less resistant to bacteria. It is not to be thought of as merely a skin disorder, but rather an indication of a systemic disturbance. Therefore the entire system should be treated. A combination of *all* hygienic measures seems to be necessary to effect a cure, most important of which are: (1) *sufficient rest* (9 hours sleep each night for adolescents); (2) *good elimination;* (3) *outdoor exercise* (an hour or more daily); and (4) the *right kind of food.*

Sweets, starches, and fatty foods are conducive to acne, while a diet high in vitamins improves the color, tone, and quality of the skin. A person trying to cure acne can well afford, for a few weeks, to eat little or no candy, sugar, sweet desserts, sodas, sundaes, jams, cereals, potatoes, fried foods, thickened gravies, coffee, tea, or spices. He should always eat an abundance of fresh vegetables (many of them raw), all fruits except grapes and bananas, and drink daily 8 or 10 glasses of water, fruit juices, and milk.

The external treatment for acne consists of the same careful cleansing as for blackheads and pimples. You may use a good sulfur or other antiseptic soap and allow the lather to remain on the spots over night. As the skin improves, wash the lather off after each cleansing and close the pores with witch hazel. Upon arising, apply hot cloths to stimulate circulation and help rid the pores of waste. Rinse with cold water. Do not use any after-shaving powders or lotions, face creams, oils, or cosmetics, at least during the first few days of treatment. After that, use them sparingly if at all. Expose the skin to the sunshine for 15-minute periods several times a day.

Once a week you may try the following treatment. After cleansing and drying the face, apply a paste made of one or two yeast cakes mixed with a little witch hazel. After it dries remove with warm water and then apply witch hazel.

Body odors. Since a person is usually not conscious of his own body odor, it is a good precaution to bathe the armpits, hands, and feet more frequently than the rest of the body, and to take a warm bath or shower daily when perspiring freely. Some patented deodorants are not safe, as they may seriously affect the sweat glands. Boric acid powder is most satisfactory, for it counteracts the odor and is antiseptic.

Excess hair. Undesirable hair on the face, arms, and legs may be made less conspicuous by bleaching with hydrogen peroxide. For legs and armpits shaving is quickest and safest. Melted wax preparations properly applied and zipped off remove hair harmlessly. Liquid, paste, and powder depilatories, however, usually are to be avoided, for some contain irritating substances that have seriously injured many people.

Warts and moles. Warts are caused by a fungous growth that usually dies within a couple of years and then the wart disappears. If, however, it produces spores that infect the surrounding area, new warts will grow.

Moles are irregularities of the skin in which the pigment is developed to a greater degree than elsewhere. So long as moles are simply little, smooth, dark spots on the skin, they are harmless; but when they develop into raised growths, their status is uncertain and they should be removed *by a physician.* If moles on a man's face and neck are constantly irritated by shaving or the rubbing of his collar, or if they occur on any portion of a person's body where they are subjected to friction from belts, straps, or seams of clothing, they may occasionally develop into cancerous growths. *Warts and moles should never be self-treated* lest they become seriously irritated or infected.

HOW TO KEEP YOUR HAIR LOOKING WELL

Unfortunately the usual treatment of hair today improves its arrangement at the cost of its life and beauty. More than ever the hair needs daily brushing and massaging to overcome the drying effects of artificial waving and drying machines. Although the cause has not been scientifically established, the fact remains that never before has there been so much early baldness among men and premature grayness among women. That the American public spends 10 to 15 million dollars each year for hair tonics alone is ample evidence of the universal need for acquaintance with the simple facts concerning care of the hair.

Stimulating the scalp circulation. As with all living cells, hair roots demand adequate nourishment, and good circulation is the first essential for their health. *Daily brushing, then, is of primary importance.* Place the brush firmly on the scalp and pull down carefully but vigorously through the hair. This not only stimulates circulation in the scalp directly, but also in the neck and shoulders. Can you tell why it is better to brush your own hair instead of having someone else do it for you? What other exercises can you think of that will increase circulation to the head?

Massage the scalp often. Place cushioned parts of the finger tips of both hands on the scalp. Use firm pressure and brisk rotary movement. Occasionally bend your head downward between your knees to help the blood flow into the head.

How to shampoo the hair. Hair should usually be shampooed every week or two, but you will have to be the judge as to the best interval for keeping your own hair healthy and attractive.

Never rub a cake of soap on your hair; it is almost impossible to wash out. Use caution with "soapless shampoos," for many of them remove too much natural oil and their continued use may cause the hair to become dull, dry, and lifeless. For best quality shampoo, make it yourself by dissolving any pure white soap, preferably powdered Castile, U.S.P., in boiling water with a pinch of borax.

94 A good, stiff-bristled hairbrush, used daily, is the main essential for attractive hair. In brushing twist your wrist so that at the end of the stroke the bristles are turned outward.

Wet the hair thoroughly with warm water. Then apply a tablespoon or two of liquid shampoo and work the lather into the scalp with your finger tips. Rinse off the first suds and repeat.

Always rinse the hair thoroughly in warm water. Rinse several times until the last water is clear. The addition of two or three tablespoons of lemon juice or vinegar in the rinse water helps remove the soap and leaves the hair soft.

Whenever possible, dry the hair in the open air in the sunshine. Otherwise, rub dry with a towel in a warm room. This is much superior to a weekly head bake in a drying machine.

Dandruff. Dead skin accumulates on the scalp and a certain amount of the resulting dandruff is natural. It sometimes becomes excessive, however, and the congealed oil drops off as little flakes of wax. Authorities do not agree on theories of the cause or treatment for this condition. *Daily scalp massage and hair brushing appear to be the best preventives as well as the best treatment for dandruff.* Hot olive oil, rubbed into the scalp and allowed to remain an hour or over night before shampooing, also is beneficial in many cases.

Conclusion. Since individuals vary greatly in the sensitivity of their skins and scalps, you will have to determine by experiment the best soap and routine for your own use. The process of keeping the skin and hair healthy need not be complicated. It requires only simple equipment such as a wash cloth, coarse towel, pure soap, warm water, a stiff hairbrush, and a few other inexpensive items.

The main principles to remember are that your skin and scalp must be nourished by a good circulation of clean blood and they must also be kept clean on the outside. Personal appearance is such a valuable asset in the modern world that good grooming pays well. It also adds to your feeling of well-being and your efficiency.

ACTIVITIES

1. Self-check on your study of this problem. See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. Making your own cosmetics. Make for yourself at least one of the following products: hand lotion, hand cream, cleansing cream, tissue cream. You may make these either at home or in the school laboratory or as a demonstration before the class. If the school cannot furnish all the material, several pupils can club together and buy it. Other pupils have found that when working in groups, they made a large jar of tissue cream (that would cost about $2 at a store) for each person at an actual cost of about 20¢ each. For recipes, see Katherine Wellman, *Beauty Begins at Home* (see References, page 255).

3. Renewing your face. Give your face a thorough cleansing with olive oil and lemon juice as described on page 250. (Persons with very tender skins should not try this.)

4. Taking care of your hair. If you do not have a good, stiff-bristled hairbrush, get one and start using it for 50 to 100 strokes daily.

5. Key words. Add these to the list in your notebook and write briefly your ideas (not merely a definition) about each:

dermis
epidermis
pigment layer
germinative layer
tan
papillae
sweat glands
hair follicle
oil (sebaceous) glands
acne
moles
dandruff

Your Health Habits

Check yourself on the following habits. Do you —

a. Have at least two warm baths a week?
b. Cleanse face thoroughly before retiring?
c. Keep hands and nails clean?
d. Guard against body odors?
e. Keep hands away from face, especially from pimples?
f. Care for your skin from the inside (*i.e.*, by diet, elimination, exercise, and sleep)?
g. Expose your skin to the sunshine, but avoid sunburn?
h. Avoid the overuse of cosmetics?
i. Brush your hair vigorously every day?
j. Shampoo your hair often enough to keep it looking soft and clean?
k. Appear clean, fresh, and well-groomed?

SUGGESTED REFERENCES[1]

Clendening, Logan, *Common Sense Health Chats*, Blue Ribbon Books, New York, 1939. (Use table of contents.)

Hamilton, Claude, "Complexion," *Health*, November, 1938.

Merideth, F. L., *The Health of Youth*, P. Blakiston's Son and Company, Philadelphia, 1928, Chap. 14.

Phillips, Mary C., *Skin Deep, The Truth about Beauty Aids*, Garden City Publishing Company, Garden City, New York, 1937.

Pusey, W. A., *Care of Skin and Hair*, D. Appleton-Century Company, New York, 1929.

Wellman, Katherine, *Beauty Begins at Home*, Covici Friede, New York, 1936.

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[1] Use also books in *General References* in the Appendix.

Unit VI. *Controlling the Body*

MOST human beings have more or less ambition for power. Some express it in an undemocratic way by attempting to dictate to other humans. Others secure their satisfaction through the harnessing of natural forces of water, air, and electricity, through explorations and research of all kinds, or through the mastery of their own work.

The most advanced members of the race are discovering that a greater thrill is to be found in conquering oneself. A baby laughs gleefully when he can get sufficient control of himself to take a step; as a child he swells with pride when he can make his fingers trace out the letters of his name; as a high-school lad he is forever practicing some kind of muscular co-ordination, such as throwing a ball into a basket or kicking it over a goal; and the discovery of an original idea produces untold self-satisfaction.

Your own struggle for control over body and mind will be made more effective by a knowledge of the control mechanism which you must use, and the conditions under which it operates best, as told in this unit.

Problem 15. *How Do Nerves Carry Messages Through the Body?*

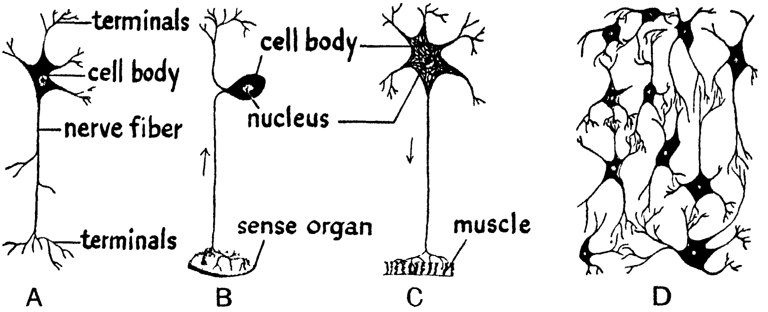
> It (the world) judges you not by the things
>   That in your heart are hid,
> Nor by the things you meant to do,
>   But just by what you did. — WALTER TRUMBULL

STUDY OUTLINE

A. The nature and arrangement of nerves
  1. What are your "senses" and how do they send "messages" to the brain?
  2. What is the danger in trying to be "psychic"?
  3. When you touch a hot object, how is your brain notified?
  4. Under what circumstances can a cut nerve grow again?
  5. How could your arm be paralyzed and still have feeling in it?
  6. How can a surgeon tell where the nerves are, so as not to cut them?
  7. What do nerves look like?

B. Acting without thinking — reflexes
  1. Why do people jump when they hear a sudden loud sound?
  2. What causes the "knee kick" and what does it indicate?
  3. How are habits formed?
  4. Why do you react faster at some times than at others?
  5. How is co-ordination of muscle action accomplished by the nervous system?
  6. Under what circumstances can you control a reflex?
  7. Of what importance is it to you that you have the mechanism for inhibiting as well as starting an act?

WHEN you grope in the dark for the light switch, you know instantly when you have touched it. Your muscles immediately receive orders as to what to do about it. How such messages can be flashed from one part of the body to another so swiftly and accurately can be understood, at least in part, by a survey of the delicate "wiring" system which carries the messages.



95 Nerve tissues — for transmitting messages. *A*. A typical nerve cell (neuron). *B*. A sensory neuron, for receiving messages in skin, eyes, etc. *C*. A motor neuron for making a muscle work. *D*. Nerve cells in the cortex of the brain.

THE NATURE AND ARRANGEMENT OF NERVES

In trying to get a mental picture of the nervous system it may help you to imagine yourself enthroned in your own brain. This brain, mighty ruler of your own self, is constantly being informed as to what is going on in all the neighboring lands. It receives all manner of informational messages from the outside world through special receiving instruments (the eyes, ears, skin, tongue, and nose) at the borders of its land. These messages are transmitted immediately from the receivers by way of special "wires." The brain cannot talk back over the same lines, but has *another* set of wires through which it sends orders to every part of its kingdom. For a concise picture of the organization of this kingdom, review page 35.

How you know what is going on outside you. Can you imagine yourself *without* eyes or ears, and unable to taste, smell, or feel anything? "Can't be done," you say? Without the five senses you would not be alive. You would be less a living unit than the tiny ameba which is sensitive to its surroundings and acts accordingly. But you were born not *knowing* any more about the world than the ameba; and all your present knowledge has come to your brain through millions of tiny feelers and transmitters called nerve cells or *neurons*. (Be sure to study Figs. 95A, B, and C.)

The sensitive ends of the neurons through which you *feel* are located under the skin all over the body. Some of these are capable of giving you only pressure sensations, others heat, and still others cold. The receiving neurons in the nose are stimulated by odors, and those in the tongue by tastes. Some other tiny antennae are tuned to receive certain sounds, and they are grouped together in the inner ear. Still others in the back of the eye are sensitive only to light. Thus, all nerve endings are specialists, each one sensitive to its own type of stimulus from the outside world and unaffected by any others. Any organs in which nerve endings are grouped for receiving similar messages are called *sense organs,* the primary ones of which are the eyes, ears, nose, tongue, and skin.

Some messages which science has not explained. You know that there are stimuli around you such as ultraviolet light, radio waves, and possibly mental vibrations, to which your ordinary sense organs are not sensitive. Man's modern study of himself has made him wonder if he is not equipped with some undiscovered mechanism for receiving certain of these vibrations. To his question, "Is there such a thing as telepathy?" science can only say that there is as yet no *positive* proof either as to its existence or nonexistence. Whether people receive messages by so-called "telepathy" has not been demonstrated scientifically.

A word of warning is needed here. In this enthusiasm for exploring man's mind, many people are being led astray by such will-o'-the-wisps as clairvoyance, clairaudience, the effort to be "psychic," to experience "sensations," "vibrations," and the like. This is a fatal mistake as it only plunges one into a sea of uncontrolled psychic forces like a ship without a rudder, and may lead to disintegration of the nervous system or "nervous breakdowns" and temporary or even permanent insanity. Whatever senses man has were given him for the purpose of helping him to *live more sanely;* anything which blights living is to be shunned as you would shun poison. Occult practices are never safe hobbies.

How messages get to the brain — sensory neurons. All of the sense organs have the same type of neuron for receiving and conducting their messages to the brain. These receiving wires are called *sensory neurons*[1] (see Fig. 95B). Each sensory neuron is a complete living cell, consisting of a pear-shaped *cell body* which has

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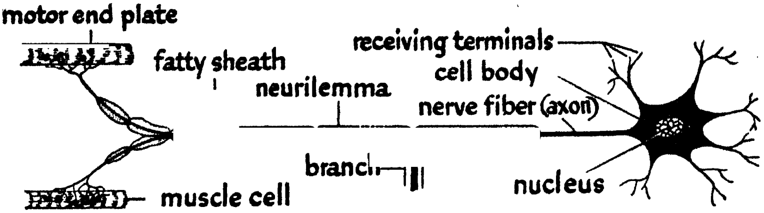
[1] These neurons are also called *afferent,* from the Latin *ad,* "to," plus *ferre,* "to carry." Can you see how they got this name? (*Motor* nerves are *efferent.*)



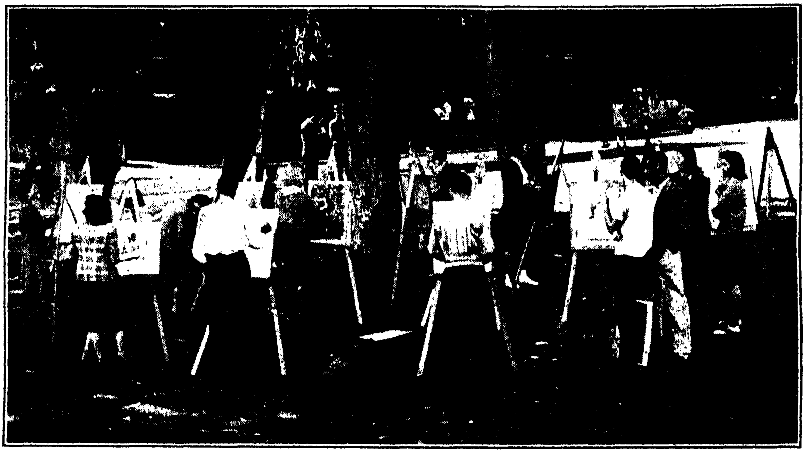
96 A motor neuron with sheaths. A cable made of sheathed fibers gives what appearance? (See text below.)

put out a branch that divides into two *fibers* extending in opposite directions. These fibers are so fine that it would take from 1,000 to 5,000 of them side by side to cover an inch. But their length varies from a fraction of an inch to a few feet. The neurons extending from your big toe to the base of your spinal cord probably have fibers 3 to 4 feet long.

Each fiber has a treelike ending, or *terminal.* The terminal at one end acts like a little receiving antenna to pick up the message; the fibers are like tiny electric wires that conduct this impulse; while the terminal at the other end passes the message on like a minute radio broadcasting station. Messages pass from one neuron to another at a place called a *synapse* (sĭ-năps′), where their terminals come into proximity with each other (Fig. 99).

Why messages don't "jump the wires." To prevent an impulse from crossing over from one fiber to another, the fibers are kept separate by a sheath of thin membrane, the *neurilemma* (nū′rĭ-lĕm′ȧ), which insulates each fiber from the others. In addition to this, many fibers have a sheath of thick, fatlike substance between the fiber and the neurilemma (Fig. 96). When many fibers of the latter type are grouped together, as in parts of the brain and spinal cord, their sheaths give the whole mass a smooth white appearance. Hence such material is called *white matter.* Can you formulate a definition for "white matter"?

Why and how cell bodies are protected. The cell body nourishes its branches; they die if cut from it. A severed cell body, however, remains alive and may grow new branches. One of nature's most remarkable feats in repair work is the manner in which the thousands of fibers of a cut nerve may grow to make the right connection in a distant part of the body, guided only by the connective-tissue



97 No matter how you express yourself you do it through muscles (and glands) stimulated and guided by your brain. (Courtesy of Los Angeles Board of Education)

sheaths which surrounded the original neurons. Such growth, however, is extremely slow.

Since the cell bodies are the life centers of the neurons, they are all located so as to receive greatest protection. Those of the sensory neurons are found in groups, called *ganglia* (găn′glĭ-ȧ; singular, *ganglion*) just outside the spinal cord but still within the bony protection of the vertebrae (see Figs. 65 and 99). Cell bodies of other types of nerves are even better protected, as they are located *within* the brain and spinal cord. In fact, it is cell bodies which make up the "gray matter" of the brain and spinal cord, for nerve cell bodies are always gray in color. Thus the living parts of all the neurons are located where they are safest, and from their protecting fortress they extend their feelerlike branches to all parts of the body.

Your mechanism for self-expression. You let other people know what you think and feel in many different ways, consciously or unconsciously. Among these may be included speech, laughter, facial expressions, gestures, music, writing, and drawing. If you will extend this list indefinitely and analyze all items, you will find that each one depends upon the use of *muscles*. Talking, for instance, is accomplished by the muscles of the larynx, the tongue, lips, cheeks, jaws, and throat, as well as by the muscles for breathing.

Even blushing is really achieved by the tiny muscles that regulate the size of the blood vessels in the face.

The only type of reaction *not* brought about by muscles is that due to *gland* activity, as, for instance when the sweat glands pour forth perspiration. Other glands, as you will learn later, have a very emphatic though indirect effect upon your actions and personality. Glands and muscles are both stimulated by nerve impulses from the brain. Therefore you may conclude that *you express yourself by the way your brain makes your muscles and glands work.*

How messages are carried from the central nervous system — motor neurons. The neurons that cause the muscles to move are called *motor neurons.*[1] Typical ones are shown in Figs. 95C and 96. For receiving the impulse from the brain or another nerve, the irregular-shaped cell body has sent out many short terminal branches. Also note that in this case the long fiber carries the impulse *away* from the cell body. This is necessary because these cell bodies are always part of the gray matter of the spinal cord or brain, and each fiber must carry the impulse from it to a muscle or gland, a distance of perhaps 2 to 4 feet. The place where the terminal branches pass the impulse to a muscle cell is known as a motor *end plate* (Fig. 96). Each nerve fiber branches into from 10 to 100 end plates and therefore activates that many muscle cells simultaneously.

Nerves versus neurons. When you speak of a "nerve," such as those indicated in Figs. 12, 98, and 99, you are really referring to a large cable of neuron fibers wrapped together. For instance, thousands of neurons are required to activate the millions of microscopic muscle cells that make up the muscles of the back of the arm. These neuron fibers all leave the spinal cord in one cable and then branch out from it to the various muscles along the way.

In exactly the same manner as motor nerves, the sensory fibers for any one locality form a large cable from the spinal cord. In many instances, as in the arm, nature has made the nerve structure still more compact by binding the sensory and motor cables for the same region into one larger nerve (note especially Fig. 99). If something should destroy only the sensory parts of the large nerves of the arm, the arm itself would feel numb — there would really be no

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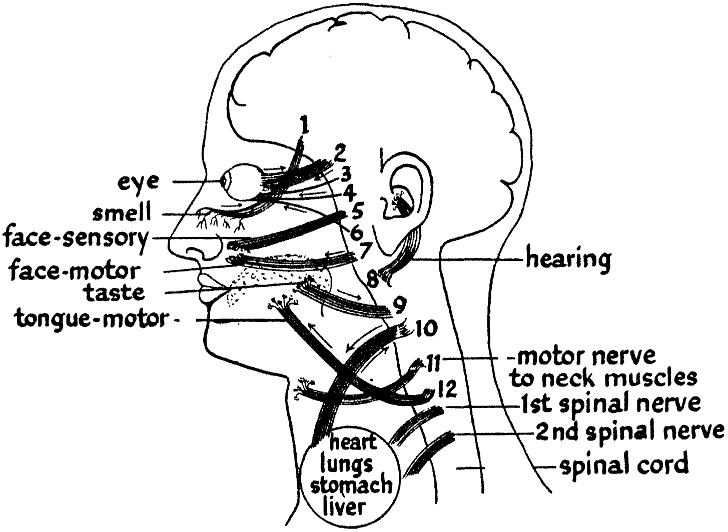
[1] The term "motor" usually refers also to neurons governing glands (*secretory* neurons). It is so used hereafter in this book.



98 Diagram of cranial nerves. These twelve pairs of nerves lead from the brain through holes in the skull to the various organs. What do the arrows indicate? How can numbers 2 and 10 have arrows going both ways? Which way should the arrow go on numbers 5 and 8?

feeling in it at all — but it could still be moved. Why? Likewise, if something should cut or destroy only the motor parts of the nerves, one would be able to feel sensations from the skin but the arm would be paralyzed, *i.e.*, unable to move. Why?

How many nerves have you? Each of your nerves has a definite location in your body and a specific purpose, just as each bone and muscle has. Nerves occur in pairs, serving corresponding parts of the two sides of the body.

From your head and neck, you have 12 pairs of nerves, which enter the brain directly and which are therefore called *cranial nerves* (Fig. 98). From your trunk, arms and legs you have 31 pairs which enter the spinal cord, one pair entering between each two vertebrae (Figs. 12, 65, and 99). These nerves are therefore called *spinal nerves*. How many large nerves have you on each side of your entire body? How many all together?[1]

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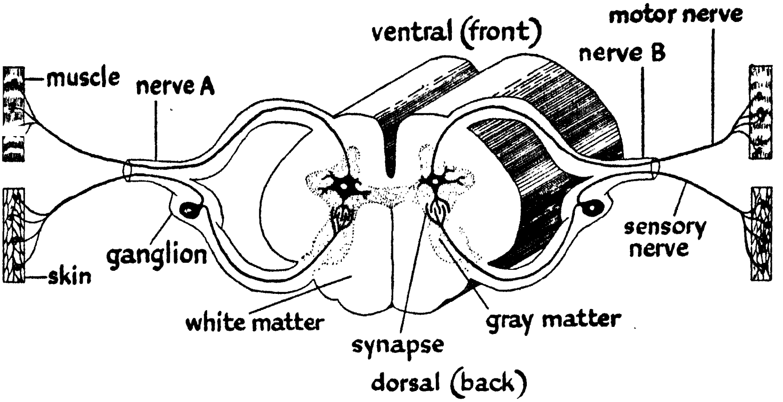
[1] These do not include any nerves of the *autonomic nervous system* which regulates the activity of the vital organs. The brain and spinal cord, together with their connecting cranial and spinal nerves, are called the *cerebrospinal nervous system*. Since *cerebro* (sĕr'ē-brô) comes from the Latin word for "brain," do you see the reason for this name?



99 Spinal cord and 2 spinal nerves. Each nerve, A and B, is represented merely by 2 neurous. The gray matter is formed of cell bodies and uncovered nerve fibers. The white matter is composed of sheathed nerve fibers running lengthwise with the cord. How many pairs of spinal nerves similar to the pair A and B are there in your body? (See text below.)

The cranial nerves. These nerves serve mostly the head, face, and neck. They carry messages to the brain from all the sense organs in the head and govern the activity of the muscles and glands which make possible such activities as talking, eating, and all facial expressions (Fig. 98). In addition, one important nerve, the *vagus*, goes to the heart, lungs, and the digestive tract and has a profound effect upon their activities.

The spinal nerves. The arrangement of the 31 pairs of spinal nerves is simpler than is that of the cranial nerves, for *every* spinal nerve has the two-in-one structure described on page 263, *i.e.*, it consists of one motor and one sensory nerve bound together.

The bundle of motor fibers arises from the front side of the cord and hence is called the *ventral* ("toward the abdomen") *root* of the nerve. The bundle of sensory fibers arises from the back of the cord and hence is called the *dorsal* ("toward the back") *root* of the nerve (Fig. 99). Each dorsal root, composed of sensory fibers, has a ganglion of cell bodies (page 262).

Summary of principles of nerve action. From the foregoing statements, the following principles should now be clear: (1) nerves are definite pathways for carrying messages *to* or *from* specific localities in the body; (2) each sensory nerve carries a "sense message" from a sense organ *toward* the brain; (3) each motor nerve carries an impulse *away from* the central nervous system to some specific muscle or gland to cause it to act; (4) each part of a nerve is either sensory or motor, but any particular fiber or neuron *cannot* be both sensory and motor, that is, each neuron can carry a message in one direction only.

ACTING WITHOUT THINKING — REFLEXES

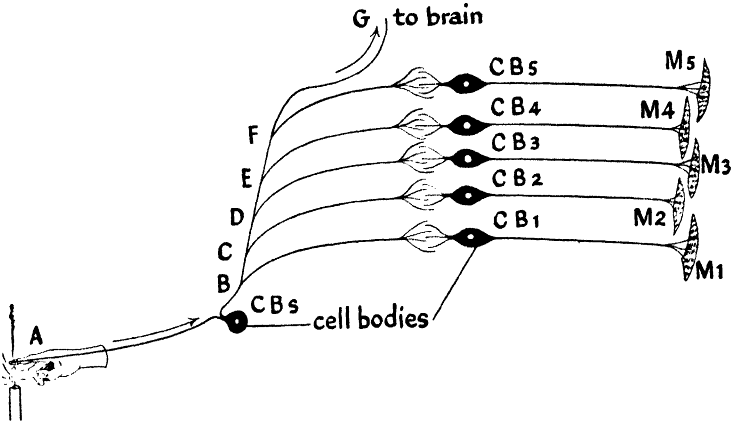
Twenty-four hours a day, even in your sleep, you receive messages through your senses and react to them. Most of these reactions are entirely unconscious, as when you blink your eyes, or make hundreds of adjustments each hour to keep your balance. The connections between sensory and motor neurons that bring about innumerable such reactions daily make a telephone office look like child's play. The principle upon which these connections work, however, is easily understood.

The simplest reactions you make — simple reflexes. There are certain situations which call forth the *same* response from all normal human beings. Examples of such actions are jumping from approaching danger and blinking the eyelid when something flies near it. These reactions do not have to be learned and in many cases cannot be controlled. For instance, *the nerves are so connected* that when sensory nerves register an obstruction in your throat, certain motor fibers automatically stimulate the muscles for coughing and you cough without thinking or even in spite of not wanting to.

To understand this mechanism, study again Figs. 13 and 99. Suppose a sensory nerve is stimulated in the skin. The impulse will travel into the spinal cord and cross the synapse to a motor nerve which will cause the muscle to work. You may imagine this as an electric shock causing the muscle to jerk the hand away. Acts of this type, in which a sensory nerve impulse directly stimulates a motor nerve, are called *simple reflexes.* The knee jerk, in which the foot is made to jerk by striking a blow just below the knee, is such an invariable reflex. Doctors use it in diagnosis because the patient cannot control it, and yet it cannot take place unless the nerves of the legs and lower part of the spinal cord are in good working order.

How several reflexes may occur simultaneously. Few acts are as simple as those just described. At the same time that you jerk your hand away from a hot stove you let your breath out suddenly in an exclamation and you may jump away from the stove.

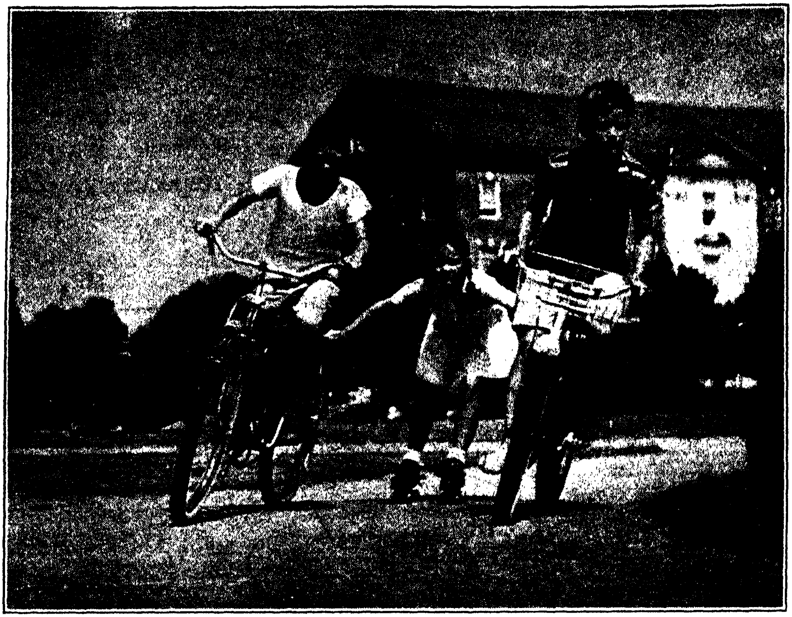
To understand how nerve connections make this possible, study Fig. 100. Notice that the sensory nerve may have several branches such as at B, C, D, E, and F, which are connected through synapses to several muscles, M_1, M_2, M_3, M_4, and M_5 respectively. For instance, if the impulse should go out through B, muscle M_1 would jerk your arm away; if through C, muscle M_2 might move the other arm to rub the shocked area; similarly M_3 might produce a vocal exclamation, and M_4 might change the facial expression. Furthermore, since reflexes stimulate the action of glands as well as muscles (as when chewing causes saliva to flow), the branch at F might induce the sweat glands to act.



100 Simplified diagram to show how one stimulus might cause several responses. All the branches B, C, etc., the synapses, and the cell bodies CB_1, CB_2, etc., would be located within the spinal cord.

Why you don't usually respond like a machine. Very few responses are as predictable as the knee jerk. You know that in most instances you cannot be sure just what a human being will do under given circumstances. You may plan what you would do in case of an accident or a holdup. But can you be certain that even *you* would act as planned?

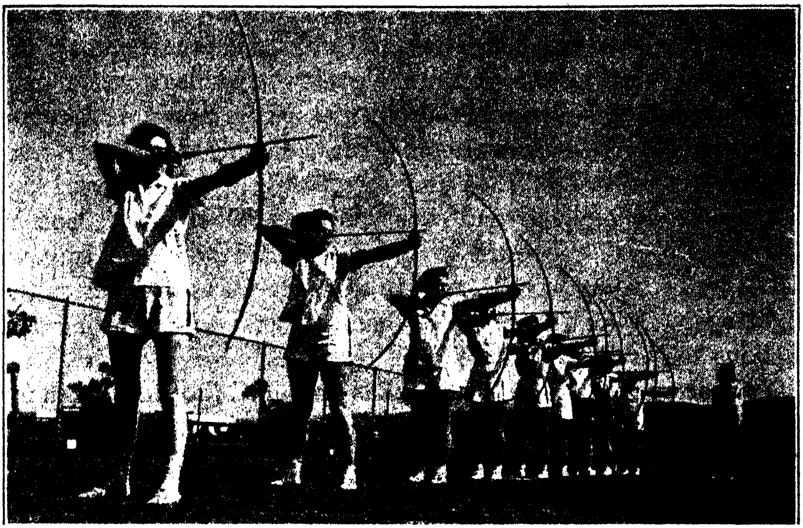
The secret of your ability to guide your acts, to vary them, and to learn new ones, lies in the fact that *the connection between any one nerve and another is not solid and unchangeable, but loose and*



101 Balancing, even for walking, requires innumerable reflexes originating in the inner ear, the eye, tendons, joints, muscles, and pressure on the skin. (Meisel from Monk-Meyer)

variable. Using Fig. 100 again, notice carefully that the *branches of any two nerves do not actually touch at any synapse.* Hence, at each synapse there is a gap which the impulse may jump, just as an electric current may leap across a small opening as it does in a spark plug. The impulses *may* or *may not* cross to CB_1 and you cannot be certain that a shock at A will always cause a jerking of the muscle at M_1. As would be expected, stronger impulses jump synapses more easily, so that the more violent the shock the more sure you may be that the arm will jerk.

How simple habits are formed. It is believed that the looseness of the structure of synapses makes it possible for a nerve impulse to cross some synapses more readily than others. The resulting action depends, of course, on the particular synapse which is most easily crossed, that is, which offers the least resistance. Furthermore, each time any impulse succeeds in getting across a certain synapse the resistance is decreased along that pathway.



102 Many popular sports of today develop precision and accurate co-ordination. Is this merely an arm exercise? (See text below.)

It is not known exactly what happens to a synapse when its resistance is decreased; possibly the branches of the two neurons draw closer together, or they may put out tiny growths toward each other, or some chemical change may take place in the space between them which aids the impulse in crossing the gap. At any rate, after a person has responded to a certain type of stimulus in a given way, say by screaming when hurt (as from D to M_3, Fig. 100), it becomes easier for him to scream than to do anything else, and we say he has developed the *habit.* Thus anyone develops habits by repeating the same act until actual changes take place in the nervous system which establish a pathway for future nerve impulses. You will learn more about this in the next problem.

Co-ordination. Through a nerve mechanism that works on the same principle as that shown in Fig. 100, a nerve impulse from the brain might be sent into several muscles at once to make them work together. Such nerve pathways have to be established by practice. For instance, if you have ever tried to shoot an arrow from a bow, you know it isn't as easy as it looks in Fig. 102. These girls have learned to make hundreds of muscles *co-ordinate* in this one act. The muscles of the arms, shoulders, and trunk must co-operate by each one pulling just the right amount; while hips, legs, and feet must be poised to give a firm base and withstand the reaction of the shot. Nerve impulses from the eye guide the whole activity.

Co-ordination is accomplished by the nerves as they stimulate one group of muscle fibers after another and guide them in performing the desired task. When you were a baby, your arms and legs flopped about aimlessly and even your eyes did not both look at the same object — because your muscles had not been trained. Little by little you have learned to send nerve impulses across the right synapses for thousands of different acts — from eating and walking to playing games and writing.

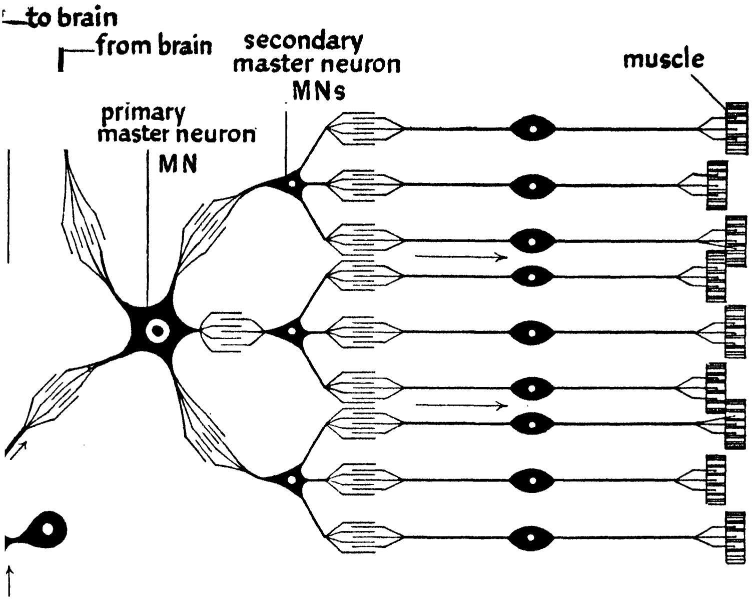
Your army of neurons. Nature has simplified the mechanism for co-ordinated activity by substituting a central *master neuron*, in place of several single cells.

In Fig. 103, note that the sensory neuron has but one branch at B instead of several as in Fig. 100. This single branch sends the impulse into the master neuron MN, which distributes it to three (or more) secondary master neurons, MN_s, which in turn relay it to the muscles and glands. In reality many more muscles than can be shown here would be affected.

Because of this type of organization, the nervous system has been likened to an army with its various ranks of officers, each in his turn commanding several others of inferior rank till at last the orders reach every individual man, and the whole vast thousands move together as one, each adding his bit to the accomplishment of the one great project.

How chemicals can co-ordinate actions. You know that the heart, the muscles for breathing, and the muscles in the blood vessels all co-ordinate their activity to meet the needs of the skeletal muscles, *i.e.*, when you exercise your legs hard, these other muscles speed up also. This co-ordination is brought about by increased amounts of carbon dioxide in the blood which affects the nerve centers in the brain, which in turn control these internal muscles.

Co-ordination of certain parts of the body is also produced by the secretions (hormones) from ductless glands (page 36). For example, an angry thought will stimulate your adrenal glands to secrete a minute amount of adrenalin into your blood. This chemical instantly increases the rate of your heart beat and breath-



103 The nervous system is organized like an army. All the muscles on the right can be made to work together by an impulse that enters the primary master neuron (MN) either from the sensory neuron (at A) or from the brain (from D).

ing, dilates the blood vessels in your skeletal muscles, stops all digestive processes, and causes several other co-ordinated reactions.

Conditioned reflexes. The word "reflex" is usually limited to those acts which do not have to be learned and those like coughing which are performed even if one is unconscious. But many acts that appear to be reflex are developed by experience, such as the flow of saliva when you hear the dinner bell, the distance you keep from a stove that is usually hot, or the motions you perform in tying your shoe laces. Such modified reflexes are called *conditioned reflexes.*

Conditioned reflexes are acquired by repeatedly performing a certain act at the same time that you receive a certain stimulus until the two become *associated* in the nervous system. For instance, if a whistle is blown every time chickens are fed, the whistle stimulus will soon become associated with the act of eating and the chickens will come for food whenever the whistle is blown. Likewise, anyone accustomed to driving an automobile may push on the floor when someone else is driving and danger looms ahead. (Watch your own reactions for other illustrations.)

Just where to draw the line between conditioned reflexes and habits is impossible to determine, but, in general, reflexes are inborn or acquired early in life, while conditioned reflexes and habits are established later and are more variable.

Your reaction time. It is possible to measure very accurately the time you require to react to a given stimulus, as, for example, to press a telegraph key after hearing a bell. Such an act is not a true reflex, for you must be conscious and the nerve impulse must travel over a much longer path and over many more synapses than for a simple reflex.

Ordinary reaction time varies from about 0.12 to 1 second, depending upon the particular test, the individual, and the condition of his blood at the time. The average individual requires about 0.63 second on an automobile driver's reaction test for applying his brakes after seeing a signal. Such tests show also that anyone's reactions are greatly slowed down by *fatigue.* This probably accounts for the large number of accidents in the late afternoon when people are going home from work — tired. Drivers should remember this fact and go more slowly and carefully when fatigued. Pedestrians also should then use extra precautions for their own safety. Tests further show that the reaction time for a man is slowed by the consumption of even small amounts of alcohol. Narcotic drugs slow reactions. (See Problem 20, pp. 355-357, 365.)

The control of reactions — inhibition Usually you cannot control a pure reflex because you do not know about it in time. Figure 100 shows what happens: the impulse goes across the reflex arcs first because these paths are shortest and simplest. Later, however, the impulse will arrive in the brain, through G, and you will become aware of what you have already done.

Even some reflexes, however, can be controlled as when you stop a sneeze by strong pressure on the lip or you hold still in spite of pain while someone removes a sliver for you. In such cases, being *forewarned,* you send an *inhibitory* impulse which is stronger than the impulse to act.

There are probably special fibers that carry the inhibitory impulses, although the exact mechanism has not been discovered.

But *the fact of the existence of inhibitory power is of immense importance, for it reveals the possibility of almost complete self-control.*

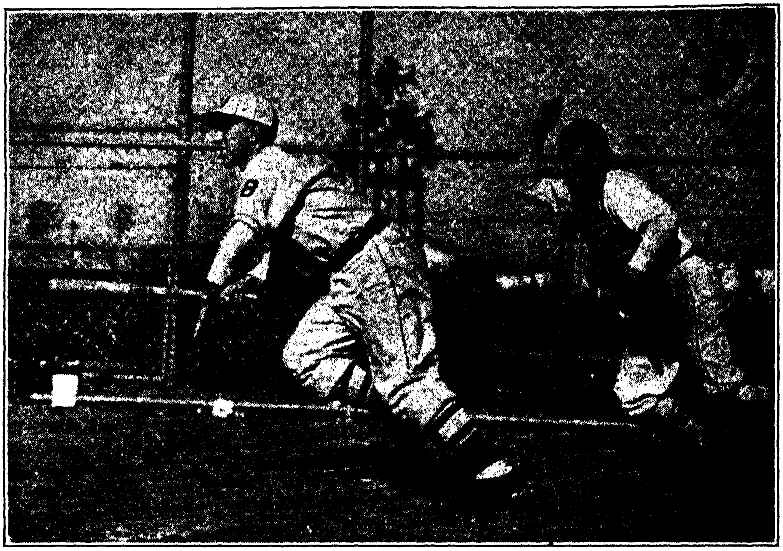
Nervous efficiency and blood chemicals. You have already learned that fatigue wastes and alcohol slow the reaction time. This extra time is used up at the synapses where most energy is expended and where the blood supply is greatest. It has been found that a nerve may be stimulated thousands of times in rapid succession without impairing it or decreasing its speed of transmitting impulses — *as long as it is bathed in clean blood.* On the other hand, it is highly probable that supersensitive, "jumpy" nerves result from the lack of proper substances in the blood, or from the presence of wrong ones. Here again you meet the now familiar general principle that *all cells act normally only when provided with clean, pure, nourishing blood.*

Summary. **1.** The general organization of the nervous system is as follows:

Nervous system
- 1. Cerebrospinal nervous system (voluntary)
  - A. Central nervous system
    - a. Brain
    - b. Spinal cord
  - B. Cerebrospinal nerves
    - a. 12 pairs of cranial nerves
    - b. 31 pairs of spinal nerves
- 2. Autonomic nervous system (involuntary)

2. The *neuron* is the unit of structure of the nervous system. *Sensory neurons* carry impulses from sense organs to the central nervous system. Each sensory neuron is "tuned" to receive one kind of stimulus only, such as light, sounds, heat, etc. *Motor neurons* carry orders to the muscles and glands.

3. *Nerve impulses* are thought to be like tiny electric currents. They must cross a gap called a synapse in order to get from one neuron to another. They may branch off on several paths, but will go where synapses offer least resistance. Hence action is variable and habits are made possible. Impulses may pass directly from a sensory neuron to a motor neuron causing reflex acts without the necessity of thought.



104 Quick reactions depend on quick reflexes, which require a clean blood stream. What blood chemicals slow one's reactions? (See page 272.)

Reactions are slowed up greatly by fatigue wastes, alcohol, and narcotic drugs. When the blood is clean most impulses may be controlled or may be entirely inhibited by will power.

ACTIVITIES

1. Self-check on your study of this problem. See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. A test of your neuromuscular control. Give yourself the following tests. Observe what reflexes you perform while doing them.

a. Lace one shoe or put a rubber on one foot while standing on the opposite foot, without any support.

b. Walk 30 feet on a rail or beam without stepping off or losing your balance at the end of the walk.

c. Stand, with eyes blindfolded, on left foot with right heel held against left knee, holding arms horizontal to aid balance.

d. Repeat (**c**), not using arms. This is the supreme test.

What do you conclude concerning the "steadiness" of your nerves and muscles? Concerning the part played by reflexes of arms and legs in keeping your balance? The part played by reflexes from the eyes? If you cannot do these "stunts," practice similar exercises daily.

3. Observation of learning muscular control. Teach a small child or an animal to do some trick. Note the "false moves" it makes. Record the steps by which it seems to acquire control of its muscles.

4. Acquiring greater control of your own muscles. Teach yourself something that requires co-ordination, *i.e.:* throwing a basketball into a basket; skating; swimming; typing; playing a musical instrument; knitting; etc.) Practice one movement at a time and then put them together. Practice slowly at first. Does this waste time or save it?

5. An oral report. Report on Pavlov and his experiments on conditioned reflexes. (*Note:* This can be made one of the most interesting reports of the course.)

6. Key words. Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each. (Add simple, well-labeled sketches where you can.)

neuron
cell body
nerve fiber
terminal branches
synapse
motor end plate
cranial nerves
spinal nerves
white matter
gray matter
simple reflex
conditioned reflex
reaction time
co-ordination
inhibition

Your Health Habits

Check yourself on the following habits. Do you —

a. Learn muscular control patiently by practicing slow movements first, when learning something new?

b. Direct the activity of your muscles so as to avoid jerky and wasted motions?

c. Direct your muscular co-ordination for careful and accurate results?

d. Increase your chances of nervous efficiency by keeping your blood stream clean?

SUGGESTED REFERENCES [1]

Haggard, H. W., *Science of Health and Disease*, Harper & Brothers, New York, 1938, Chap. 14. (Also see index.)

Kennedy, Foster, and Stevenson, L., *Your Nerves and Their Control*, D. Appleton & Co., New York, 1928, Chap. 2.

Williams, J. F., *Personal Hygiene Applied*, W. B. Saunders Company, Philadelphia, 7th ed., rev., 1941, Chap. 12.

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[1] Use also books in *General References* in the Appendix.

Problem 16. *How Do the Brain and Spinal Cord Direct Actions?*

The greatest happiness in life comes through complete self-mastery. — ROY L. SMITH

STUDY OUTLINE

A. Nature and action of the brain and spinal cord
  1. Why doesn't your brain jolt when you walk?
  2. What is the spinal fluid? What is its purpose?
  3. Why is the brain spoken of as "gray matter"? What is white matter?
  4. What do general and local anesthetics do to a person? Are they dangerous?
  5. Why is a patient strapped down before an operation? If he cries out while under the anesthetic, is he in pain?
  6. If part of your brain were removed, how would it affect your acts? Would it matter which part was removed?
  7. How can you learn to do things (like walking) automatically while thinking of something else?
  8. How can a person walk and talk in his sleep?

B. Developing the powers of your brain
  1. Can initiative be developed or must you inherit it?
  2. How can you learn self-control?
  3. How can you develop a good memory?
  4. What are dreams? Do they mean anything?
  5. What tricks are there to forming and breaking habits? Can all habits be changed?
  6. How can you retain your ability to learn?

NO ONE can tell how the brain works. No one has ever seen one work. If you could view it in action, doubtless you would see no more motion or change in either the brain or nerves than you see in a telephone wire when people talk over it. Hence scientists have but two principal methods of studying this most mysterious of all mechanisms: (1) to study the structure of the *brain* and then deduce how it must work; and (2) to study the laws of *mind* by observing one's own thoughts and actions and the reactions of people and animals under certain circumstances.

The first method is employed by physiologists; the second by psychologists. The findings of both groups are interesting and practical, for they help people to understand themselves and to use their minds and nervous systems more effectively. This problem is devoted to a brief discussion of some of the most useful things discovered in both fields.

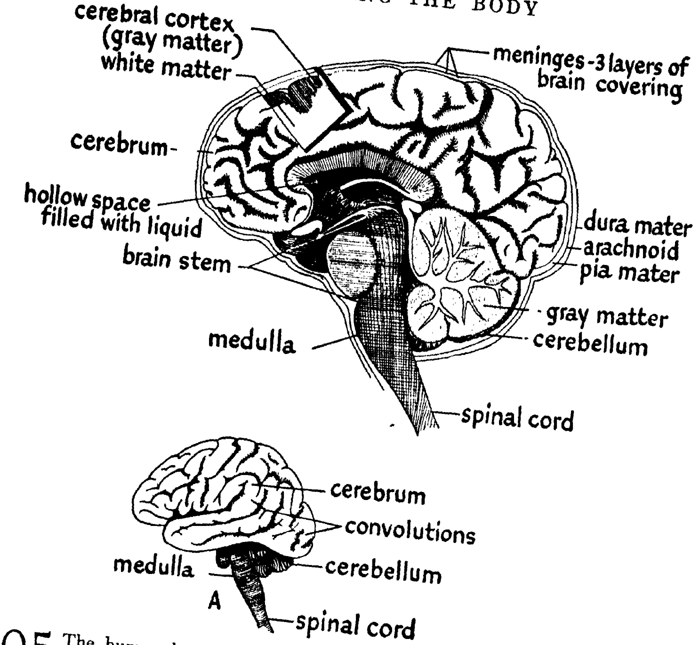
NATURE AND ACTION OF THE BRAIN AND SPINAL CORD

For efficient co-operation, any army of workers must receive orders from some central authority. Your army of muscles and glands co-ordinate their activities marvelously because all their orders come through a central switchboard — the brain and spinal cord.

Housing of the central nervous system. The brain and spinal cord are composed of the most delicate tissues in the body and therefore have the best protection. The *brain* is encased within the skull and is protected from friction against this bony housing by three layers of membrane called *meninges* (mĕn-ĭn′jēs) (Fig. 105B). The spaces between these layers are filled with the lymphlike *cerebrospinal fluid*, which protects it from being jarred.

The *spinal cord* is continuous with the brain like a root growing out from it through a large opening in the base of the skull. The cord is protected by a bony channel, the *spinal canal*, formed by the hollow spaces of the vertebrae (see Figs. 64 and 65). Inside the canal the cord also is wrapped in fatty tissue and the same membranes and lymph coverings as the brain.

Structure of the brain. The brain itself is a soft wrinkled mass about the shape of a walnut meat cut in half. It weighs about 4 pounds. A deep groove extends through its middle and divides the top part into two *hemispheres*, the right and the left. These are joined together only at their base by a band of fibers. These two large hemispheres make up the *cerebrum* (sĕr′ē-brŭm), the seat of thought and of the highest type of brain activity. Just



105 The human brain. *A*. Viewed from the side. *B*. As seen by vertical section. Fluid seeps among the cells from the outer coverings to the inner cavities. What is the purpose of this fluid? (Hint: Purpose of all lymph?)

below, in the base of the skull, is a much smaller division known as the *cerebellum* (sĕr′ē-bĕl′ŭm), which is the center of automatic acts like walking. The cerebrum and cerebellum are connected with the spinal cord by the *brain stem*.[1] There are several divisions of the brain stem, but the one next to the spinal cord, known as the *medulla* (or *medulla oblongata*) is the most important as it is the nerve center which governs the action of such vital organs as the heart and lungs.

Within all these parts are numerous communicating spaces and channels which finally narrow into a small tube that runs lengthwise through the center of the spinal cord. These spaces are filled with the same cerebrospinal fluid that bathes the outer surface of the brain. This fluid is constantly being drained off through the lymphatic ducts and large veins of the head and hence helps maintain the proper nourishing and cleansing environment for the cells of the brain and spinal cord.

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[1] The terminology of the brain makes reading in this subject difficult for students. Some terms the student will commonly find are explained in the Glossary.

Intelligence and general brain structure. If you can dissect a sheep's brain, you will notice first the deep wrinkles on its outer surface. A human brain would have many more of these. They are called *convolutions* and are believed to be a great factor in intelligence, since less intelligent brains are smoother. It is thought that intelligence depends upon the number of brain cells. The cells are located in the outer layer of the brain, and the area of this surface is increased by being folded. Hence brains with more convolutions have room for more cells and would be expected to be more intelligent.

This belief is supported also by the fact that mere size of brain does not determine intelligence, as brain size is proportional to body size and the largest people and animals are not necessarily the most intelligent. Women have smaller brains than men merely because of their smaller body size.

Gray matter and white matter. As mentioned in Problem 15, gray matter is composed chiefly of cells. Since the cells are located in the outer layer of the convolutions, this layer is gray matter (Fig. 105). It is called the *cortex*. Brain cells are similar in structure to other nerve cells (Fig. 95D). The fibers from the millions of cells of the cortex connect it with the other parts of the brain and the body. Together, these fibers form the brain stem and some of them become the white matter of the outer part of the spinal cord. It is supposed that the gray matter is the special apparatus for thought and consciousness; white matter merely conducts messages.

Functions of various parts of the central nervous system. Many experiments have been performed on animals to determine just what types of actions are controlled by each part of the brain and spinal cord. One method used is to render a part of the central nervous system inactive or to disconnect it entirely (by a painless operation) and then observe carefully which acts are now impossible without that part of the brain. Evidently, the missing acts were controlled by the nerve centers that have been deadened. The results of these and other interesting experiments may be summarized briefly by the following chart, which should be read upward, starting at D with the simplest types of acts possible, and increasing in complexity as higher parts of the brain are added.

Part of Central Nervous System	*Type of Acts It Makes Possible*	*Special Remarks*
A. Cerebrum	Consciousness Will power Initiative Memory, learning Speech, writing Reason, etc.	"Self-starter" Activity — essential to being alive mentally Can make man the master of himself and his environment
B. Cerebellum and brain stem up to cerebrum	Walking — *provided* given stimulus to walk Avoiding obstacles in path Balancing the body Sitting erect	All automatic acts Animal unconscious of acts or pain No acts started by self-will No acts improved by experience
C. Medulla or bulb	Respiration (breathing) Vasomotor reflexes Heart beat	Governs minimum activity essential to being alive physically
D. Spinal cord	*Simple reflexes* Pulling leg away when pinched Scratching or kicking where skin is irritated	With cord alone there would be no "life" — *no* breathing or heart action, no upright posture — only simple reflexes so long as cells are alive and intact

Referring to the chart, an animal with only a spinal cord intact, like a chicken immediately after being killed, can perform only the acts given in row D, column 2. Why does it flop about? Again, a person who had been given enough ether to deaden the cerebrum and cerebellum would still have both spinal cord and medulla intact and would therefore be able to live, for he could do everything shown in rows C and D, column 2. Walking in one's sleep is a case where only the cerebrum is asleep or inactive. Hence, as seen by row B of the chart, the uncanny acts of such a person in balancing himself on narrow ledges and performing simple everyday deeds are explained by the fact that the central connections for such acts

106 No matter what the machine, its marvels cannot compare with the brain of the human being that invented it nor of the one who uses it. (Courtesy of the Los Angeles Board of Education)

are in the cerebellum. Notice that being *really alive* requires that all parts of the nervous system be awake, alert, and healthy.

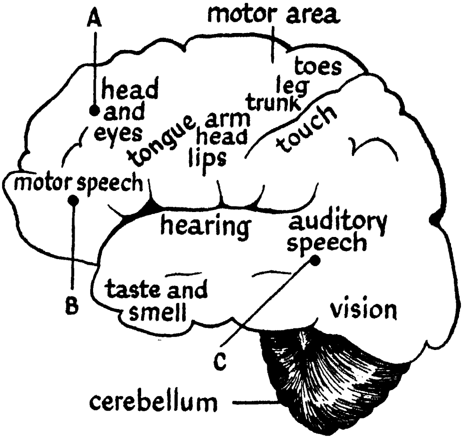
This chart shows how it is sometimes possible to do two different kinds of things at once. Driving an automobile is one of the most complicated activities in which people commonly engage, yet an *experienced* driver apparently automatically avoids objects and ruts in the road, stops at signals, shifts gears, and regulates his speed and course according to the cars about him. Yet he may converse some with his passengers. Nevertheless, we know his driving is not truly automatic; for if he becomes too interested in the conversation the car may leave the road or run into something. This shows that *the cerebrum must be in constant control,* guiding the automatic and reflex acts.

When one is learning to drive, the activity of the cerebrum is extremely apparent; for it seems as if he has a hundred and one things to think of all at once. He *consciously* has to direct every movement. But gradually his cerebellum and reflex centers take up the automatic acts like shifting gears, using the brake, and making adjustments of steering and speed. This leaves the cerebrum free for the important business of constantly adjusting to the ever changing environment and being alert to meet emergencies.

Effect of anesthetics. When a person "goes under" any general anesthetic, like ether, his *central nerve centers* become paralyzed in regular order. Hence he loses his faculties in the order given on the chart, from the top down. When just the cerebrum is affected, he becomes unconscious and unable to feel pain; but the automatic and reflex centers remain active. Therefore the patient may do much struggling and screaming and the onlookers may worry if they do not understand that these acts do not represent any real suffering.

In most major operations enough anesthetic is given so that all but the simplest reflexes disappear. The danger point is near when the eye reflexes disappear — those of winking when the cornea is touched and closing of the iris when light shines into the eye. Therefore these reflexes are watched closely, because soon after they disappear the effect reaches the medulla with its nerve centers for the heart beat and breathing. To interrupt these, of course, means death. For this reason it is imperative that no one ever be allowed to undergo a general anesthetic unless he has a doctor or nurse whose *only* duty is to administer the anesthetic and watch these reflexes. With such an attendant, however, and the necessary preliminary blood tests and physical examination, no one need fear the effects of general anesthesia.

A local anesthetic is applied merely to the region to be operated upon. It is harmless, for it dulls merely the nerve *endings* in that locality (as around a tooth, tonsil, or abscess) so that they are incapable of sending the pain impulse to the brain.



107 Diagram to show parts of the cerebrum connected directly with the muscles and sense organs.

How the brain is connected with muscles. Experiments and microscopic studies have shown that the neurons of certain portions of the cerebrum are connected with specific motor nerves of the body. For instance, a section of the cortex from ear to ear (Fig. 107) has cells which, when stimulated, move various muscles of the body. For this reason it has been called the *motor* area. The fibers from this area cross over in the medulla and descend through the opposite side of the cord. Thus, if the motor area of the left side of the cerebrum is damaged, the parts or all of the right side of the body will be paralyzed, and vice versa.

It is not to be thought that orders to move the body *originate* in this area; thinking and willing are doubtless far more complicated than that, and the "order" probably is the fused impulses from a vast number of neurons in other parts of the brain. When this nervous energy reaches a certain motor center, it discharges impulses to the particular muscles connected with that area.

How the brain is connected with sense organs. Certain *sensory areas* also have been established (Fig. 107). Directly back of the motor area is a region which receives impulses from the skin all over the body. The back part of the cerebrum receives messages from the eyes; destruction of the cortex here results in blindness even though the eyeballs remain perfect; the optic nerve fibers are so crossed and distributed that injuring the left side of this visual area causes loss of vision of the right *half* of the scene as viewed from either eye. The auditory nerves, also, cross over so that each ear is connected mostly with the opposite cortex. The impulses for smell go to the lower surface of the brain.

These specific sensory receiving areas do not actually do the "seeing," "feeling," "hearing," etc. They are only the first centers for receiving the nervous impulses from their respective sense organs. They apparently relay these impulses to the millions of neurons in the "association areas," to be described later, which are necessary in order to interpret what the impulses mean. In fact, the brain seems to work *as a whole*, all of its millions of neurons and synapses being necessary in order properly to receive, interpret, and respond to nerve stimuli.

Where ideas are put together — the association areas. The most marvelous thing about your brain is the way in which it hooks all the sensory impulses together, gives meaning to them, and causes you to act accordingly. Sensory impulses through the eyes of 30 children who see a circus elephant for the first time may bring forth 30 different types of response — *each response rooted in some previous experience of that particular child.* Gradually, as they watch the animal move and eat, hear the noise it makes, and perhaps touch it, all these different types of sense stimuli become *associated* or fused into one idea of "elephant," so that each child thereafter will recognize an elephant or a picture of one by associating it either consciously or unconsciously with this one. Everything you "know" has been built up from some kind of sensory experience that affected your cerebrum in some way.

How has the cerebrum performed these complicated processes? That mystery may never be solved. It is known, however, that association of ideas takes place in the parts of the cerebral cortex not used as sensory or motor areas. The large portions of the cerebrum between and around these areas (Fig. 107) seem to be reserved for the purpose of putting together the impulses from the specialized areas. Hence they are called *association areas.* They are the latest development in nervous systems and represent the crowning achievement of all creative effort. They make possible all learning, memory, thinking, reasoning, and intelligent behavior, including will power and self-control.

The network of thought neurons. The association areas are an intricate network of millions of cells with a seemingly infinite number of possible synaptic connections (review synapses, page 268, and Fig. 95D). The fibers from these cells do not connect with the brain stem and cord, as do the sensory and motor areas.

Instead, they merely connect various areas of the cortex with each other. Thus, in the elephant illustration, all the sensations of sight, hearing, touch, and smell entered first the sense areas of each child's brain. From there they entered the association areas which put them together into the one idea — "elephant."

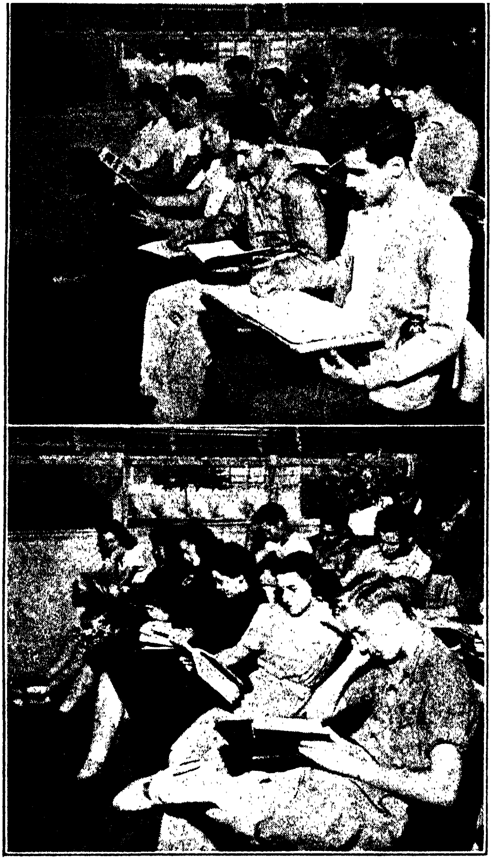
In putting these sensations together, however, the associative cells added something which resulted from all the ideas that had gone through them before. Likewise, these cells will carry into all future experiences of each child something of this present one, for they have formed a new synaptic path and will never be quite the same again. Of course, if a child should never again see, hear of, read or think about an elephant, that synaptic path will be largely erased by other impulses; he will have "forgotten" what an elephant is. But if he should see one fifty years later, the synapses would doubtless "recall" for him this childhood experience.

How much gray matter can you spare? No particular cells seem to be responsible for "storing" a memory. If a section of the association areas is injured or destroyed, no one specific effect like deafness or paralysis results as it does when a certain sensory or motor area is destroyed. Instead, injury to these areas is apt to result in an impairment of general intelligence. There are cases on record, however, in which large sections of this cortex have been removed by wounds or operations with no definitely noticeable loss of ability by the patient. Apparently, other portions of the cortex took up the work of the lost cells.

Of course, if too large an area is injured or all the association cells are weakened by a poisoned blood stream (as in acute alcoholic intoxication) or by general deterioration (as in certain brain diseases or sometimes in old age), then the impulses seem to cross the synapses helter-skelter, and the person is said to have "lost his mind" either temporarily or permanently.

DEVELOPING BRAIN POWER

You have doubtless already discovered some ways of developing and mastering your own mental abilities, but you may still profit greatly from the discoveries made by scientists. Hundreds of



108 Good posture and fresh air are great aids to brain work. The pupils in the top picture will learn better and be much less tired than those in the picture below.

thousands of painstaking experiments have given results which can help anyone use his brain more efficiently. He need only apply what others have discovered concerning the way the nervous system works best.

Developing initiative. At some time in your life you came to realize that you had the ability to *start* things. Many individuals use this ability in a purely infantile way; they may start mischief, but they wait for their parents and teachers to tell them everything to do — to get them up in the morning, to prompt them in home duties, to remind them when the bell rings, and then to guide every detail of their work! They have simply not awakened to the fact that they are endowed with a real self-starter in the upper brain.

You can train yourself to take responsibilities by just *practicing taking charge of yourself first,* appointing yourself sole executor of certain simple duties until you do them habitually and on time. Then you may add other duties gradually.

Some young people go to the other extreme of trying to "run their own lives" before the cerebrum has stored up enough experiences to enable the association centers to put things together in the right proportions to form sound judgments. Though it is trying on most young people, they should rely in serious matters on the judgment of the finest older people they know until their own starting and regulating mechanism is matured. Then they must have the courage to go ahead and take the initiative on their own responsibility.

Inhibitory power of the cerebrum. Valuable as is the power of initiative, it is disastrous without control, like a locomotive with a powerful engine and no brakes. Fortunately, you have been given power of control along with initiative, and it is located in the same organ, the cerebrum.

When you stop to think of it, this controlling power of inhibition is one thing you admire so greatly in persons of high character, for they do not do certain things that weaker persons would do under the same circumstances. They resist temptation; do not flinch from danger or a difficult task; do not fly into a rage upon slight vexation. Through experience and practice such people have exercised the inhibitory nerve mechanism so that it responds instantly when called upon to control more primitive and animal-like reflexes. In fact, they have trained it to act automatically. Thus self-control is not something with which one person is born and another is not. All children, except the feeble-minded, are born with the inhibitory apparatus, the same as they are born with arm muscles, and it must be developed in the same way — by *exercising* it.

Learning — training the synapses. From our knowledge of nerves and the brain, it may be concluded that the learning of ideas is a matter of getting the impulses across the proper synapses of the brain. Likewise, developing automatic co-ordinations such as the technique of writing, typing, playing a musical instrument, or using tools, depends upon consciously directing the impulses across the proper synapses governing the muscles until the impulses travel them easily.

Your blood stream and your brain power. If the blood contains excessive amounts of wastes or other substances not normally present, the brain may function little or not at all.

If the blood stream is loaded with fatigue wastes, it may be next to impossible to learn anything. Experiments have shown that healthy nerves may become practically incapable of carrying an impulse simply by being bathed in lactic acid from fatigue. Therefore, save time and energy by doing your mental work when you are most rested, or by taking rest periods. Studying when too tired is inefficient, for it means that work is done slowly and poorly.

Hints for efficient learning. To learn anything more quickly and surely, try the following suggestions, which are based on facts:

1. *Pay attention* to what you are trying to learn, for only then do the association areas seem to get impulses connected properly in the synapses. Try to become *interested*, for then your cerebrum is more alert and ready for action.

2. *Get the satisfaction of accomplishment.* The mere knowledge that a lesson is done well helps you to remember it. For older children and adults, the feeling of pride in good work should be sufficient without any dependence upon the praise of others and much less upon the necessity of being "paid" for every achievement or favor.

3. *Practice* or *review* the material to be learned. You should not expect to learn a lesson by reading it once without at least *thinking* it through several times again, paying special *attention* to the main points.

4. *Associate* the new facts with each other and with things you already know. You cannot return to school after an absence and expect to understand everything the same as if you had built up all the connecting links! Absence makes school work difficult and is the real cause of many failures that are attributed to "dumbness."

Skim a lesson before studying it to get a grasp of the general plan; then, when you go over it in detail, the parts will fit together and be more easily associated. Outline the main points after studying them and use the outline for review. This method has proved one of the best ways to see *relationships* between ideas and to remember them.

5. *Get your ideas from as many different sources as possible.* Don't try to learn from books alone. Modern schools furnish you opportunities to learn through pictures, models, laboratories, shops, tools, art materials, speech, music, phonographs, radios, dramatic presentations, and physical education. The more you actually participate in these instead of just watching the teacher or the other fellow, the more effective will be your learning.

Develop the habit of using your hands as well as your eyes when you study — draw your own diagrams to explain certain ideas, jot down notes, make outlines, model things "in the air" or of real materials, and act things out. Use your voice and ears by explaining things aloud either to yourself or to others. Whenever you learn a worthwhile fact, *use* it if you want to remember it.

Helping your memory. You cannot *remember* anything unless you once *learned* it well. As inferred previously, you do not store "pictures" in the brain; you merely change synapses. Hence training your memory is chiefly a matter of applying the hints for learning just given.

Save nervous energy by not trying to remember too many details. Write down appointments, plans for the day, and grocery lists, and form the habit of always putting the list in a given place. When studying, don't waste energy trying to memorize unimportant things; let many small ideas grow into a big one and then fix the large, general idea in mind. In textbooks, the section headings, parts in bold-faced type and italics, summaries, and conclusions help you to pick out the important ideas.

Cramming never results in permanent learning. Real learning requires time for the synapses to build up the proper connections. This calls for patient, day-by-day study and concentration.

Dreams. Very little is actually known about dreams. They probably are indefinite flashings of nerve impulses skipping about among the neurons. Hence they may have something to do with your past or present experiences, but they have nothing to do with your future. The actual content of the dream means nothing, though its *type* may reveal something concerning the physical and nervous state of the body.

Harassing dreams of the day's problems may show that the dreamer needs to master those tasks, or that he needs a vacation or a change of work. Dreams of catastrophies are usually brought about by bodily discomfort due to indigestion, cramps, heart palpitations, and the like. Many dreams are started by some external stimulus such as a bell, a voice, or tight clothing.

Habits. A habit is formed when a synaptic pathway, or "behavior pattern" has become so well established that nervous energy discharges along it without the conscious control of the cerebrum.

Hence, if properly understood and used, habits can be great savers of thought, time, and energy. Prove this by definitely trying to establish habits to take care of routine matters such as arising at the same time, having a definite method of procedure in dressing and preparing for bed, having an established place for work and study, and working out the best method of taking care of health and daily duties. It pays in time and nerve energy to plan such activities, then establish the habits to take care of them, leaving the mind free for more interesting things.

Wrong habits may be great destroyers of happiness and even life. Petty habits that annoy others often ruin an otherwise likeable personality; selfish habits cause discord in homes, playgrounds, and offices; while alcohol and drug habits are wrecking millions of lives and rendering countless others unhappy. Hence habits should always be kept under control; never allow them to control you.

To establish a new habit practice the desired act regularly, permitting no "backsliding." You may need some kind of a reminder at first. To break a bad habit do just the opposite — never allow yourself to do the undesired thing, and substitute a good habit in its place. Family and friends can often be enlisted to help in the campaign against a habit enemy by making you conscious of it and making it easier not to do it.

Does age affect learning? The common belief that it is difficult or even "impossible to teach an old dog new tricks" is erroneous. The ability of older people to learn depends upon whether the synapses have been kept pliable by constantly acquiring new ideas. If people have not tried to learn anything new for many years and have gotten into mental ruts, they will find learning very difficult. But a great many middle-aged people can learn more effectively than in youth, because they have kept on learning, and have developed better techniques. Many energetic aged people have not grown old mentally because they have never allowed their mental machinery to get out of practice.

Conclusion. The association areas of your brain are constantly merging together the different impulses from your sense organs to form ideas. Each nerve impulse (thought) alters the synaptic connections in your brain, so that you cannot be exactly the same at this moment as you were an hour ago. Each thought and experience leaves its imprint for good or evil, hence, "Your tomorrow is going to be what your today makes it" (— COLEMAN COX).

Scientists cannot tell what the energy is that flashes at lightning speed through the intricate network of brain fibers and synapses to produce thought. They can merely describe the *machinery* and tell you how to use it more efficiently. You may improve your ability to learn and remember by: (1) interest and attention; (2) satisfaction in the result; (3) repetition and practice; (4) association of ideas with each other; (5) stimulation of ideas through as many sensory avenues as possible; and (6) control of your thoughts and habits, not permitting them to control you.

ACTIVITIES

1. **Self-check on your study of this problem.** See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. **Dissection of a sheep's brain.** If possible, obtain a sheep's brain with skull partially removed. Note the lining of the skull and covering of the brain. If the skull is removed carefully, you will be able to see also the pituitary gland at the base of the brain. Identify principal parts of the brain. Note how a few cranial nerves enter the brain. Cut a piece from the cortex and note the difference between the white and gray matter. Cut the brain carefully through the center from front to back. Can you identify the parts mentioned in the text? Note the relationship between the brain and spinal cord. Note how the brain, spinal cord, and cranial nerves are related to the skull.

3. **Improving your study habits.** List ways in which you waste time, and things that distract you. Arrange your study conditions and time to eliminate as many of these as possible. To improve your powers of concentration, practice setting yourself a reasonable amount of work to do in $\frac{1}{4}$ or $\frac{1}{2}$ hour, and try to make yourself finish it in that time. (Do not sacrifice quality of work for speed.) After practicing in short periods for a week, increase them.

Begin using the hints for efficient learning on page 288. Practice them one by one for four or five days when studying the same school subject. (It may take that long to master the *method.*) Keep a record of your progress.

4. **Form some new good habit.** Keep a record of your progress daily until the habit is firmly fixed.

5. Break some undesirable habit. Try for a few days merely to stop doing the undesirable thing. Then try replacing it with a better habit (*i.e.*, chewing gum may replace smoking. Later the gum-chewing habit may be broken). Which is easier, merely to stop a habit or to replace it? Keep a daily record of your success.

6. Key words. Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each:

cerebrum
cerebellum
medulla
cerebrospinal fluid
meninges
initiative
inhibition
learning
habits

Your Health Habits

Check yourself on the following habits. Do you —

a. Try definitely to concentrate on what you hear and read?

b. Do your school work *regularly* so as not to miss any links in the chain of ideas? (This makes it easier for you.)

c. Consciously assume responsibilities and faithfully perform them?

d. Control your thoughts and habits?

e. Constantly form good habits that will make you more efficient?

SUGGESTED REFERENCES [1]

Berry, R. J. A., *Your Brain and Its Story*,* Oxford University Press, London, 1939. (Very advanced but excellent.)
Dorsey, G. A., *Why We Behave Like Human Beings*, Harper & Brothers, New York, 1929.
Fisher, I., and Emerson, Haven, *How to Live*, Funk and Wagnalls, New York, 20th ed., 1938. (Use index.)
Furst, Bruno, *Use Your Head, The Practical Use of Memory and Suggestion*, Funk and Wagnalls, New York, 1939, Chap. V.
Irwin, O. C., "New Brains for Old,"* *Hygeia*, August, 1939, p. 689.
Popenoe, Paul, "Lefthandedness," *Hygeia*, October, 1938, p. 893.
Starch, D., Stanton, H. M., and Koerth, W., *Controlling Human Behavior*,* The Macmillan Company, New York, 1936.

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[1] Use also books in *General References* in the Appendix and references for Problem 15, page 275.

* For advanced pupils and teachers.

Problem 17. *How Do You Receive Messages from the World about You?*

The senses collect the surface facts of matter. — EMERSON

STUDY OUTLINE

A. Messages through nose, tongue, skin, and interior of body
   1. What things can injure the sense of smell?
   2. Why don't things taste right when you have a cold?
   3. Why does a piece of meat between the teeth feel so big to the tongue while the fingers can't feel it?
   4. Do you feel temperature, pressure, and pain through the same nerves?

B. Messages through the ears
   1. Why do your ears have a peculiar sensation when going up or down many floors in an elevator?
   2. What should you do about an earache?
   3. What is a mastoid infection? How can it be avoided?
   4. How can you prevent ear disease in general?
   5. What mechanisms assist you in maintaining your balance?

C. Messages through the eyes
   1. In what respects is the eye like a motion-picture camera?
   2. How is the eye constructed and how does it function?
   3. If a person loses one eye, can he see just as well as with two? Why?
   4. What are the most common eye defects? What causes them? What can be done to prevent them? To cure them?

D. How to have good eyesight for life
   1. What do mental habits have to do with eyesight?
   2. How may you maintain proper lighting conditions?
   3. What seeing habits help preserve eyesight?
   4. What first-aid treatment is it safe to give for eye injuries?
   5. How can you relax your eyes?
   6. How can you strengthen them?

ALL of your thrilling experiences are brought to you through your senses — the beauties of nature, the inspiration of music, the hand clasp of friends, the fragrance of flowers, the taste of good food! How much of life would be cut off by dulling any one of these delicate sense organs that connect you with your outer world! This problem should help you to keep your senses and nerves healthy and capable of registering accurately and quickly the stream of messages that make up the experiences of life.

MESSAGES THROUGH NOSE, TONGUE, SKIN, AND INTERIOR OF BODY

The senses of smell and taste are closely related and were doubtless developed for protection from injurious substances. They have proved also to be avenues of keen pleasure. Nerve impulses through the skin guide such acts as writing and walking in which the pressure of one movement becomes the reflex signal for the next one. The sense of touch is so fundamental and unfailing it often is called upon to replace sight and hearing.

How you smell odors. The nose is the only place in the body where nerve endings are exposed to the outside world without any covering. The nerve cells for smelling, the *olfactory* (ŏl-făk′tô-rĭ) cells, are located in the upper part of each nostril. Each cell has 6 to 8 hairlike projections that extend through the mucous-membrane lining of the nose. The tiny nerve fibers from these cells come together into a bulb, from which the nerve impulses are sent via the *olfactory nerve* to the brain.

The exposed nerve endings probably are affected chemically by tiny gaseous particles given off by substances having odors. Also, the nerve endings are so situated that odors reach them only as you breathe in. Hence you sniff when trying to detect an odor.

Your sense of smell becomes fatigued quickly. When you enter a room filled with a strong odor, it is very noticeable; but soon it is no longer apparent to you. For this reason the sense of smell will not guide you in determining ventilation or household and personal-cleanliness problems. These must become matters of habit.

The care of the sense of smell. This consists chiefly in maintaining a healthy condition of the mucous membrane of the nose.

The things that commonly injure this membrane are frequent colds, chronic catarrh, hay fever, etc. Also, the continued use of strong nose drops and inhalers probably impairs this sense; they should be used only as emergency measures and as little as possible. In general, the nose should be left alone and cleaned only by its own natural secretions.

How you taste flavors. Your tongue feels rough because it is covered with small projections, or *papillae* (pȧ-pĭl′ē), within which are located tiny *taste buds*. Each taste bud contains many *taste cells*, with hairlike processes for receiving the taste stimulus. The inner end of each cell contacts the taste or *gustatory* (gŭs′tȧ-tŏ̇-rĭ) nerve which carries the impulse to the brain.

The taste cells are stimulated by the chemical effects of food. Nothing can be tasted until it is in solution. There are but four distinct kinds of taste — sweet, sour, bitter, and salty — each of which affects a different part of the tongue. All the other "flavors" are combinations of these, or are odors, temperature effects, or irritations by certain spices. Try tasting common foods while holding your nose. You will soon see that, to some extent, "taste" is really smell.

Preserving your sense of taste. Some of the things which ruin one's ability to appreciate and enjoy delicate flavors are: eating too much highly seasoned food; the habitual use of tobacco or alcohol; and anything which may permanently injure the sense of smell so that the odor element in taste is impaired. Cleaning the teeth or drinking some water before a meal enhances the taste of food because it cleanses the mouth and tongue.

Training the sense of taste. At the present time so many proved facts are known about diet that you can in part guide your taste scientifically. If you don't like certain foods, you can learn to like them by repeatedly eating small amounts, or by mixing them with other foods and gradually increasing the proportion.

You must distinguish between natural and acquired cravings. The body manifests natural desires for the things it needs such as water, sugar, salt, and calcium. On the other hand, certain acquired tastes, such as that for narcotics, have no natural basis. The body's first reaction to them may be of dislike, or even of nausea. This is a warning that they are unwholesome. Unfortunately, if you repeatedly ignore the warning signs, your body will cease its resistance, and a bad habit is acquired.

Messages received through the skin. The sense of "touch" is really four *cutaneous* (kŭ-tā′nē-*ŭs*) senses — *pain*, *pressure*, *cold*, and *warmth*. Within many of the papillae of the skin (Fig. 90) are delicate clumps of nerve terminals, each of which is sensitive to its own kind of stimulus. Pain nerves, however, are affected by any kind of extra strong stimuli.

Messages from within the body. Some nerve endings are deeper than the skin and report the internal condition of affairs such as hunger, thirst, and pain. Sensory-nerve endings in the muscles and tendons keep you informed as to how your muscles obey orders.

MESSAGES THROUGH THE EARS

Twenty million people in the United States are hard of hearing. These people are just like you and me, except that their impairment requires a tremendous adjustment of their lives (Fig. 109). Since many of them never adequately make this adjustment, they develop distorted personalities.

Many persons have been deafened through ignorance and carelessness, and their handicap could have been prevented by the knowledge and practice of a few simple rules for the care of the ear.

Sounds. When you hear a loud sound your ears hurt because particles of air have actually bombarded it with great force. It is important to remember that all sounds are caused by vibrations of particles of matter. They may be injurious to the ear if they pound against the eardrum too hard. Water and solids transmit sound vibrations more easily than air; hence ears are easily injured by sounds made under water while a person is diving. Explosions also may rupture the eardrum.

The outer ear collects sounds. The outer ear is formed mostly of cartilage[1] and is shaped so as to collect and direct sound vibrations along the *ear canal* (Fig. 110) to the drum. This canal is so short that in children the eardrum may be seen; hence it is

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[1] The "cauliflower ear" of boxers results from crushing blows which allow blood to enter the space between this cartilage and its covering.

109 Getting the feel of it. A class for the deaf. So that hard-of-hearing persons may take their places among others, they should be taught lip reading — whether they are young or old. (Courtesy of Los Angeles Board of Education)

extremely important that nothing be allowed to enter the canal. Sharp instruments like hairpins or toothpicks are especially dangerous. The ear is somewhat protected against dirt and insects by tiny hairs which grow in the canal, and by ear wax secreted by glands in the passageway. Remove only the wax that comes out on a wash cloth with ordinary bathing. If the wax should become so impacted as to obstruct the passage, it should be removed by a physician. *Under no circumstances should anyone except a physician attempt to remove wax or beans, peas, or other objects from the ear.* Teach children to keep small objects out of their ears.

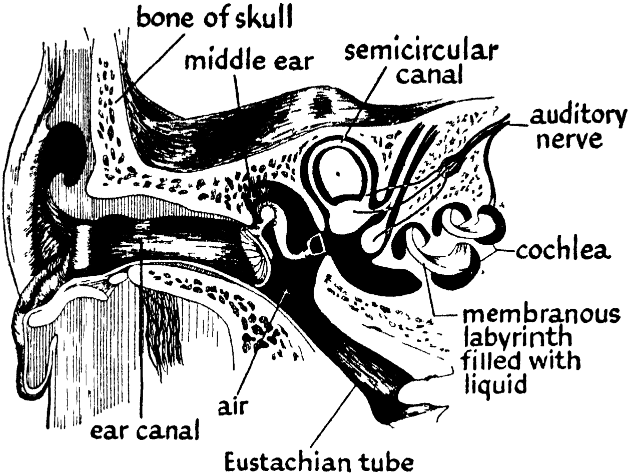
The middle ear transmits sounds. The sound vibration, upon reaching the drum, produces a series of rapid little pushes which set it vibrating. The *eardrum* is a membrane stretched across the end of the canal. Its vibration is transmitted across the middle ear by means of three tiny bones called the *ossicles* (ŏs′ĭ-k'ls) — the *hammer*, the *anvil*, and the *stirrup*.

The space surrounding these bones is filled with air which enters through the *Eustachian* (ū-stā′kĭ-ăn) *tube*, leading from the pharynx (see Figs. 110 and 53). Each of these tubes (one for each ear) is so narrow that its walls usually come together and close it. If the air pressure becomes less outside the body, as in going up in an elevator, the air inside forces the tubes open until the air pressure inside the cavities equals that on the outside. When you go down in the elevator, the outside air again forces the tubes open until the pressure is equalized on both sides of the drum. If the pressure is unequal on the two sides, the drum cannot vibrate freely and the result is poor hearing. When you have a cold, the inflammation sometimes closes the tubes and makes hearing difficult.

The inner ear receives sounds. The third bone, or stirrup, passes the sound vibration into a liquid in the inner ear. The inner ear contains the real hearing mechanism, consisting of (1) a hollow bone called the *bony labyrinth*, which forms a series of canals and chambers; and (2) the *membranous labyrinth* that just fits this bony covering (Fig. 110). The space between the membranous labyrinth and its bony cave is filled with a fluid known as the *perilymph.*

The bony base of the stirrup fits into an oval-shaped opening — the *oval window* — in the bony labyrinth. The stirrup is held in place by a pliable membrane which covers the oval window. The vibrations are transmitted from this membrane to the perilymph and from there to the membranous labyrinth. The snail-shell part of the membranous labyrinth, called the *cochlea* (kŏk′lē-ȧ), contains the nerve terminals for receiving the sound stimuli; thence the impulse is transmitted to the brain by way of the *auditory nerve.*

Now trace a sound vibration to its destination. Use Fig. 110 and the following synopsis of the story: Sound vibrations in air pass through the outer ear and auditory canal and cause successive vibrations of: the ear drum → hammer → anvil → stirrup → perilymph → membranous labyrinth → auditory nerve → brain. A long story? Yet all of it takes place in the minutest fraction of a second! A portion of this story still is enshrouded in mystery. No one knows, for instance, just what takes place in the membranous



110 Diagram of the human ear. The eardrum is the membrane closing the inner end of the ear canal. Can you trace the path of a sound wave from the outer air to the auditory nerve?

labyrinth that enables you to distinguish your mother's voice from that of others, and to recognize the difference between a note from a violin and one from a piano.

Ear and mastoid infections. When anyone has a cold, the closing of the Eustachian tubes by inflammation of the pharynx is a protection to the ears, but people sometimes carelessly force open the protecting barrier by blowing the nose too hard and forcing the infection up the tubes into the middle ear. The result may be abscesses affecting the drum and ossicles and causing temporary or permanent deafness. If not treated, the collected pus may rupture the drum and cause a "running ear," or it may overflow the middle-ear cavity and spread to the *mastoid air cells* which honeycomb the bone just behind the ear. This extremely painful condition, called *mastoiditis*, is serious because of the thinness of the wall between these cavities and the brain, and the nearness of a large blood vessel. To prevent the infection from reaching this vein and the brain it may be necessary to remove the external surface of the mastoid bone and clean the air cells from the infection. Because of these serious dangers every cold should have careful attention and *every earache should be attended to immediately by a physician, especially if it is accompanied by a fever.*

Causes of common ear disorders. We may summarize the chief causes of ear disorders as follows:

1. Colds and infections of nasal passages, sinuses, or throat. Large adenoids and diseased tonsils should be removed.

2. Direct ear infections caused by objects or liquids entering the ear canal.

3. Impacted wax. This should be removed by a physician only.

4. Diseases that sometimes leave hearing defective — typhoid, typhus, tuberculosis, measles, scarlet fever, diphtheria, mumps, diabetes, syphilis, rheumatism, and hardening of the arteries.

5. Injuries — boxing of ears, fracture of the skull, sudden loud noises, constant loud noise. These often produce injuries that can never be repaired.

6. Hereditary tendencies.

How hearing affects speech. The nerves of the speech and hearing organs are so closely connected that you unconsciously try to imitate the sounds you hear. Normal children learn to speak by imitating the speech of others, but children who are born with impaired hearing or who, in infancy, acquire an ear defect do not learn to speak correctly. Hence many speech defects are really *ear* defects.

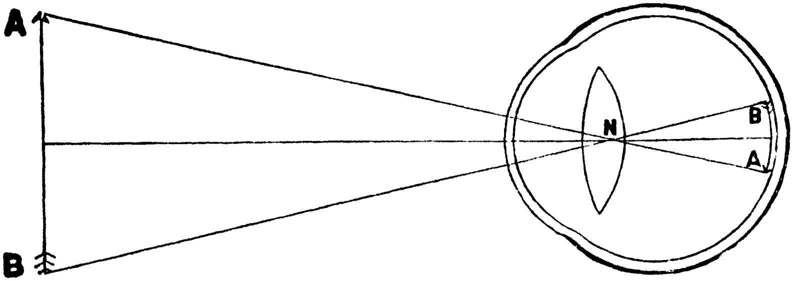
Your sense of balance. Are you surprised by the caption under Fig. 111? The *semicircular canals* of the inner ear are like three minute automobile tires placed at right angles to each other (Fig. 110). They register, respectively, (1) motions on one level as when walking or riding, (2) motions of falling forward or backward, and (3) motions of falling sidewise. All other motions are a combination of any of these three.

The semicircular canals are filled with lymph into which project tiny hairs. According to the most acceptable theory, when the body moves, it jars the lymph, which drags the hairs in one direction. The hairs pass the resulting impulse along their branch of the auditory nerve to the brain. In the cerebellum these nerve fibers are connected by reflex arcs with the muscles in other parts of the body, particularly the legs. These connections make possible the many balancing reflexes that are required constantly to maintain equilibrium in all vertical positions, sitting, standing, or walking. Reflexes from the eyes and joints also aid in maintaining this balance.

111 People who attempt this must have healthy ears. Although balancing involves reflexes from eyes, joints, tendons, muscles, and pressure on the skin, these alone will not suffice without the aid of the inner ear. The family shown above are the Hubert Castles, of circus fame. (Photo by Karger from *Pix*)

MESSAGES THROUGH THE EYES

No organ of the body is abused as much as the eyes, yet sight probably contributes more to the joy and ease of living than all the other senses together. Experts estimate that at least three fourths



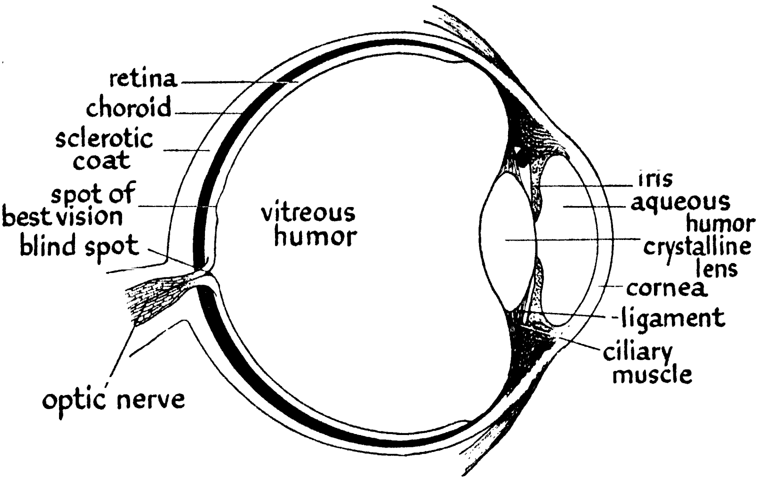
112 Diagram showing how the image is formed on the retina. Note that the image is small and inverted. Your brain, however, interprets it as seeing an object right side up. (From Mitchell's *General Physiology*, McGraw-Hill Book Company, New York)

of the cases of eye disorders could be prevented by an understanding of how the eyes work, and by the simple, correct habits of using and caring for them

How the eye "takes pictures." The eye is the original motion-picture camera. It takes, develops, and transmits to the brain a series of pictures at the rate of 30 to 40 "frames" per second, more than twice the ordinary speed of the motion-picture camera. Observe, from Fig. 112, that the eyeball is like a camera box; it holds the lens and film and, except for a small hole in the front, it keeps light out. The *eyelid* acts as a shutter.

The *crystalline lens* (Fig. 113) brings light rays to a focus on the living film, or *retina* (rĕt′ĭ-nȧ), which lines the rear inner surface of the eyeball. The retina is responsible for the eye's ability to take pictures in rapid succession. It is a thin tissue of nerve endings which are sensitive to light. The nerve fibers from these terminals form a cable, the *optic nerve,* which transmits the nerve impulses to the brain (Fig. 113). In about $\frac{1}{40}$ of a second the retina has erased one picture and is ready to receive another. If you turn your head rapidly, however, it does not have time to recover between pictures and things look blurred.

Mechanisms for greater clearness of vision. Other parts of the eye, as well as the retina, must keep pace with your rapid movements. By means of the co-ordination of muscles and nerves your eyes continually readjust their direction, refocus their lenses for each tiny change in distance from the objects you are looking at, and regulate the amount of light each time your glance falls



113 Diagram of the human eye. While your eyes are open, most parts of each eye are constantly changing shape and position. Can you tell which ones change and why?

upon a darker or lighter object. The parts needed for all these fine adjustments are shown in Fig. 113. Follow the diagram as we consider each part separately.

1. *The "box" of the eye camera* consists of a tough protective tissue called the *sclerotic* (sklê-rŏt′ĭk) *coat*, which would collapse except for the liquid inside it. It is smooth and white and part of it shows as the "white of the eye." The front part of it, called the *cornea*, is thin and transparent to let the light in.

2. *The dark lining*, or second layer, is called the *choroid* (kō′roid). It contains pigment to protect from inside glare, and many capillaries for nourishing the eyeball.

3. *The film*, or *retina*, is the third layer. It is a delicate membrane, yet it contains 10 layers, some of nerve fibers, others of capillaries, and still others of thin regular cells. The light has to penetrate the top 8 layers to reach the ninth or real seeing layer. This layer consists of millions [1] of cells called *rods* and *cones*. These are end organs which start nerve impulses for seeing. Vision, then, depends on chemical changes brought about in the rods and cones when light falls on them.

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[1] "There are as many nerve endings in the human retina as there are total hairs on the heads of a population of 1500 people." — *Seeing*, The Western Institute of Light and Vision, p. 28.

The cones, which are thickest near the center of the retina, are for discerning shapes and color. Color blindness is due to their faulty functioning so that a person cannot distinguish between certain colors. It is very rare among women and is hereditary, as well as acquired, in men. As the acquired type comes on suddenly, engineers, motormen, and automobile drivers should be required to take periodical tests for color blindness.

The rods are located chiefly around the side portions of the eye. They detect movement around the edges of the object you are viewing. They also enable you to see in partial darkness, an ability which decreases with age. Practice seeing in darkness (as in a *blackout*) by looking a little to the *side* of objects, not directly toward them.

The *spot of best vision* for daylight seeing is the central portion of the retina, about the size of an ordinary pinhead. When you look at anything carefully, you unconsciously focus the image on this tiny spot. Look steadily at one word and note that others around become blurred. Hence *to read best you should keep shifting the eye from one word to the next.* The practice of reading a whole line at a glance is not natural and is hard on the eyes and the whole nervous system, as the eyes cannot focus on so large an area.

There is a *blind spot* in each eye where the optic nerve leaves the eyeball. To prove this, close your left eye and look steadily at the X below with your right eye. Keep your attention on the X and move the book first closer and then farther away. When you cannot see the O, its image is on the blind spot. Repeat, closing the right eye and focusing the left eye on the O. Why is no blind spot noticeable with both eyes open?

X **O**

4. *The part for regulating light* is the *iris* (ī′rĭs), the colored section of the eye. It is a circular muscle with a hole in the center through which light enters the eye. The hole, called the *pupil*, looks black because there is no light behind it.

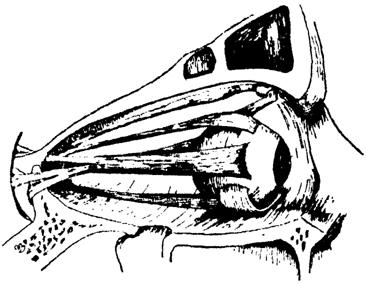
The iris protects the retina from too much light and obtains a sharper image by eliminating extra glare. When you step suddenly from the dark into bright light, the iris muscle contracts, making the pupil smaller. This requires a little time, during which you should look downward to shield the eyes. If you read by flickering or streaked light, the iris muscles are overworked, constantly adjusting themselves to the light and dark spots.

5. *Liquid lenses* are formed by fluids, the *aqueous humor* and *vitreous humor*, within the eye (Fig. 113). These liquids are necessary to maintain pressure within the eyeball and give it its shape. Both humors aid the lens in bending light rays, for their shapes make them truly lenses.

6. The *crystalline lens* is composed of a colorless, jellylike substance. Its natural shape is convex (*i.e.*, thicker in the middle than at the ends). A circular ligament that is attached around its rim holds the lens suspended from the choroid coat. A greater pull on this ligament causes it to pull harder on the lens which then becomes thinner; less pull on the ligament permits the lens to become thicker. The eye uses this means for focusing. Its ability to make the lens more or less convex is called the *power of accommodation* or the eye's ability to accommodate itself to near and far objects.

7. *The ciliary muscle for focusing the eye.* The tension on the ligament, hence the thickness of the lens, is regulated by a ring muscle, the *ciliary muscle*, in front of the ligament. Usually a muscle pulls directly on a ligament, but this muscle is so placed that it *pulls against* or *counteracts* the normal pull of the choroid coat and ligament. Hence for close work the ciliary muscle has to work to allow the lens to become thicker, while looking at a distance allows the muscle to relax.

8. *The external muscles of the eye* direct both eyes toward the same object and aid a little in focusing. Each eyeball has three pairs of muscles. Two pairs — four muscles for each eye — are called *rectus* (rĕk′tŭs; plural *recti*, rĕk′tī) *muscles* and are attached from the eyeball to the back of the eyesocket, as shown in Fig. 114. One pair works like reins, pulling the eye to either side. The other pair pulls it up or down. Normally, when one muscle pulls, its mate relaxes. But at times of emotional stress or when straining to see at a great distance, *all four* of these muscles may become tense at once. Careful measurements show that such tension pulls the front part of the eyeball back in the socket a little and flattens it. If long continued, this may distort the shape of the eyeball resulting in farsightedness (Fig. 116C).



114 External muscles of the eye. There are four rectus muscles and two oblique muscles. Can you locate all six of these muscles?

The third pair of muscles, the *oblique* (Fig. 114), is attached at the top and bottom of the eyeball over pulleylike loops near the nose. These muscles pull the eyes downward and inward, and upward and inward. (When you roll your eyes in their sockets, you use all six muscles one after another.) If both oblique muscles pull at the same time, they squeeze the eyeball and make it a little longer. This action aids in focusing for near objects; but if it becomes permanent, it may result in nearsightedness (Fig. 116B).

Summary of how the eye focuses. How all parts of the eye work together to produce a clear image is beyond anyone's conception. It is known that the eye uses two methods of focusing on near objects: chiefly *by increasing the convexity (thickness) of the lens* and, to a lesser degree, *by lengthening the distance between the lens and the retina.* For far objects the eye reverses these adjustments.

The normal eye sees objects 20 feet or more away with the least effort, for then the ciliary muscles are relaxed and the rectus and oblique muscles are just tense enough to hold both eyes in the same direction. For closer objects the ciliary muscle contracts to thicken the lens, and for very close objects probably the oblique muscles also help a little by making the eyeball longer until the two reach a perfect balance. To observe how quickly the muscles make this adjustment, look out the window, then suddenly try to read. You will have to be quick to note the brief instant when the words look blurred before becoming clear. If you read while in a moving vehicle, the distance from eyes to book is constantly shifting and all these muscles must change continually to keep the focus. This strain may cause a headache or reflexly upset the stomach.

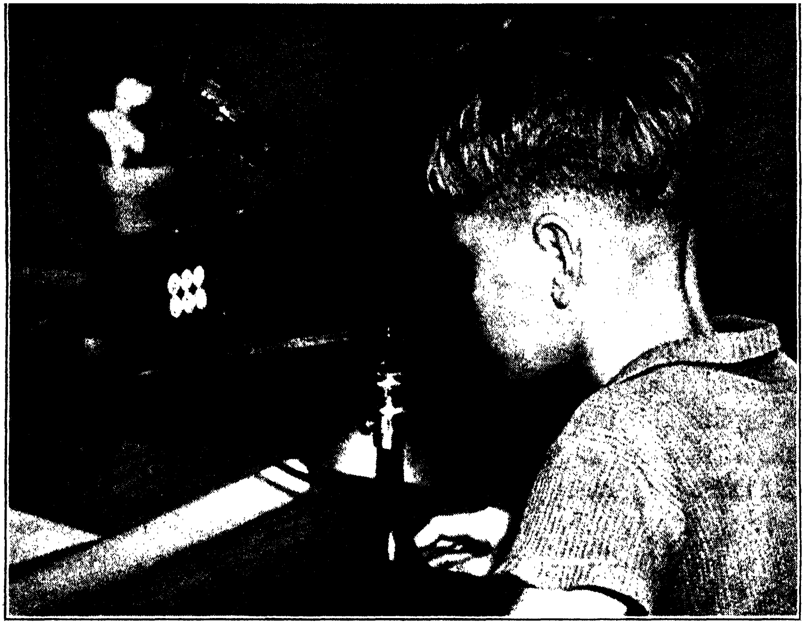
Eye accessories. The eyes play by far the most prominent part in expressing one's personality, yet the muscles that express emotions through the eyes also serve very practical purposes. The *eyebrows* shade the eyes from overhead lights and keep out perspiration. The *eyelids* are shutters to keep out light and protect from flying objects. They also keep eyes moist and cleansed by constantly spreading a small amount of tears under the lids. The tears come from a gland under each eyebrow, called the *lacrimal* (tear) *gland*. These glands continually secrete small amounts, but if you are under emotional strain or if the eye itself is irritated. larger amounts (tears) are discharged.

How both eyes work together. In some lower animals like fish the eyes look in opposite directions and so view a large space. Human eyes see the same object and hence are more accurate. Because the eyes are a little distance apart, one eye sees farther on one side of an object than the other. When these two views are co-ordinated in the brain, the picture seems to have *shape and depth* like a stereopticon picture — three dimensions — instead of being flat like a snapshot.

But the greatest advantage in having two eyes is to *judge distance*. Try putting your index finger down quickly on a given spot when you have one eye closed. You can judge the distance more easily with both eyes open because then the brain judges the tension of the rectus muscles which keep the two eyes directed on the same object. A closer object requires greater tension, as you will feel by watching your pencil with both eyes as you move it from arm's length up to a few inches in front of you. The rectus muscles shift the direction of the eyes and change tension at great speed to guide you through fast traffic. The person with one eye is tremendously handicapped in this respect, having no accurate muscle tension to judge by.

Modern methods of treating eye imperfections. It is an astonishing fact that one fourth of the young people and three fourths of all people over 50 years of age have defective eyesight. As already indicated, eyes may become unable to make clear images because (1) some part of the eye is out of shape (as in nearsightedness, farsightedness, and astigmatism), or (2) some of the eye muscles or the lens become inelastic or tense and are then unable to make rapid, extreme, or delicate adjustments (as in "old-age sight" and cataract), or (3) the external eye muscles become unevenly balanced (as in cross-eye).

Some eyes are imperfect in shape at birth, but why a once perfect



115 Specific eye exercises are now prescribed for many eye troubles which are due to weak or unbalanced eye muscles. This boy is doing corrective eye exercises. (Courtesy of Los Angeles Board of Education)

eyeball should develop any of the afore-mentioned defects has caused much argument and investigation during the last half century. These studies have resulted in the theory that many eye defects are caused by weak or tense or unbalanced eye muscles and that these muscles can be trained just as other muscles are trained. Consequently, thousands of people with eye defects are now receiving prescriptions for special eye exercises, proper diet, and mental hygiene (Fig. 115). Although spectacles do not cure[1] a defect but only relieve the pain and strain of it, they are one of the greatest blessings science has brought to mankind and are still necessary in such cases as (1) old-age defects, (2) long-neglected eye disorders, and (3) cases of inborn defects. They should also be used by people who do severe, long-continued close work where glasses may relieve the strain on the eye muscles.

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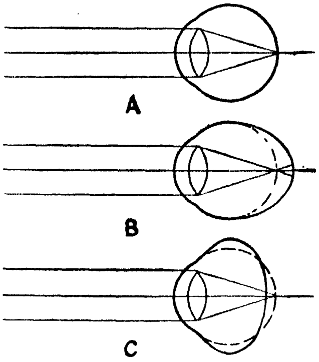
[1] Keep in mind the distinction between the words "relieve" and "cure." A broken leg may be "relieved" by using a crutch but it is "cured" when the bones knit. Also, as in all healing, a "cure" cannot be permanent if the person continues to do the things that caused the disorder.



116 Nearsightedness as well as farsightedness are caused by a misshapen eyeball. The exactly correct lens can bring the image onto the retina as in a normal eye. *A*. Normal. *B*. Nearsighted. *C*. Farsighted.

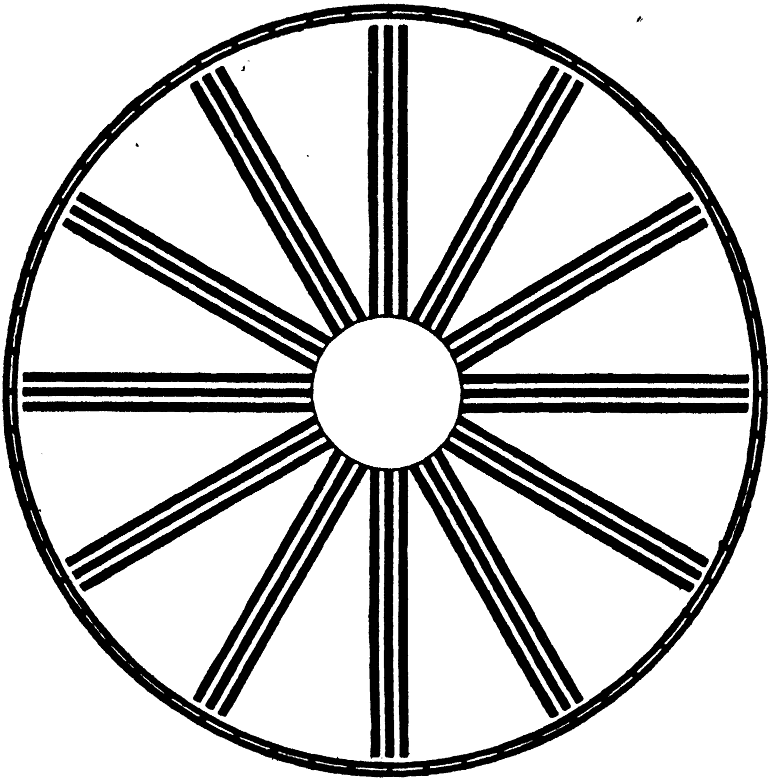
Whether an individual needs glasses cannot be determined by anyone except an expert. All defective or strained eyes should be examined by an eye specialist who will prescribe treatment or glasses or both to fit the particular case. No two pairs of eyes are alike. Often the general bodily health has to be treated, as well as the eyes.

1. In *farsightedness* (hypermetropia) the eyeball is habitually too short, as shown in Fig. 116C, and only distant objects are seen clearly. The condition is relieved by wearing convex lenses to bring the focus onto the retina, but many cases may be improved by exercises that relax the constant tension of the rectus muscles and strengthen the oblique ones.

2. In *nearsightedness* (myopia) the eyeball is too long, as shown in Fig 116B, and only near objects are seen clearly. This condition is often brought about in children by tenseness due to nervous strain probably owing to the newness, noise, and excitement of school. Reading posture also is a contributing factor, as careful measurements show that when the head is bent over, the eyeball becomes a little longer from the weight of the liquids in it. (Compare the eye to a balloon filled with water.) Hence it is important to form the habit of holding the book up while reading (see Fig. 118).

Nearsightedness should be relieved by concave lenses. These do not correct the muscle difficulty, however, and usually stronger and stronger glasses are needed throughout life. Many cases are improved by correcting the reading posture, relieving the nervous strain by a more relaxed mental attitude, and persisting in eye-relaxing exercises, as well as wearing glasses.

3. In *astigmatism* either the cornea or the lens is out of shape, having a curvature like an egg instead of that of an orange. This defect is sometimes inborn but often comes on in the teens, possibly as a result of nervous tension, emotional or mental shock, insufficient sleep, long use of eyes under poor conditions, or anemia.



117 Test for astigmatism. Close one eye and look at the center of the figure. Do some lines appear darker than others to you? If so, see page 309.

An uneven cornea or lens cannot bring all the light rays to a focus at the same distance and the person sees one part of an object more distinctly than another part, though he is not aware of this. Figure 117 gives a simple test for astigmatism. Cover one eye and look steadily at the center of the figure. If the eyes are astigmatic, some lines will appear darker than others; if normal, they will appear alike.

If it is fixed, astigmatism may be relieved by glasses made so as to counteract exactly the unevenness of the cornea or lens. It may be further relieved by improving the physical and mental health and by several months of persistent relaxing exercises.

4. In *cross-eye* (strabismus) the eyes do not focus on the same object because of unbalanced external muscles. This condition

sometimes results from certain diseases that may paralyze one or another of the external muscles of the eye. Often, however, it dates from babyhood. Normally, a baby's eye muscles are not strong enough to fix both eyes on the same object until he is about 1½ years old. By that time he may have formed the habit of seeing with only one eye while the other makes no effort to focus. A baby's crib should be placed where he can see without always looking in the same direction and there should be no bright lights or sudden movements near him because the violent muscle action easily strains his untrained muscles.

Cross-eye requires care by a medical specialist. The sooner a child gets such treatment the better. If the condition is variable, the child needs an unusual amount of rest and freedom from excitement. He must be taught to relax, especially his eyes. In severe cases an operation to adjust the muscle usually proves successful.

HOW TO MAINTAIN GOOD EYESIGHT FOR LIFE

By striving to avoid the causes of the eye defects mentioned in the previous section you may go far toward preserving the most valuable of your senses. Here are a few simple suggestions for avoiding eye disorders.

Develop emotional poise. If you watch people who are worried or fearful, you will note how the muscles of the face are drawn. The muscles about the eyeball are under even greater tension, though you do not see them. The eyes cannot escape suffering sooner or later if one allows himself to feel disturbed habitually. Learn to be relaxed and at ease even when you are busiest. Problems 19, 21, and 22 will help you to do it.

Refuse to use eyes under poor conditions. If seeing conditions are wrong, correct them, or, if that is impossible, postpone all eye work. Even if this means reorganizing your whole daily program or changing the lighting and furnishing of your home, it is worth it. Efficient seeing requires two things: *good sight* plus *good light.* Strain due to uncorrected eye defects or improper lighting forces you to spend more energy to see and makes you nervous generally. Worst of all, continued eye strain ultimately weakens the eyes and brings about some defect.

118 Correct posture for reading is the first essential taught in remedial reading classes. (Courtesy of Los Angeles Board of Education)

Avoid all glare, either direct or reflected from mirrors, pictures, glossy paper, shiny tables, etc.

1. *Never* have an unshaded light globe visible. "Light is made to see *by*, not to *look at*."
2. Sit with your back or side to the light, *not* facing it.
3. Use a modern diffusing lamp for visual work.
4. Wear a visor for close work.
5. Prevent window glare by Venetian blinds, if possible.
6. Never have shadows, spots, or streaks of light across your work.
7. Avoid sharp contrast between your work and the background. Have the whole room always at least one tenth as bright as the brightest spot. (Even an automobile headlight produces no glare in light surroundings.)

Have sufficient light on your work. You are more in danger of having too little light than of having too much. Accurate tests have proved that *with brighter lights you use less energy to see, you read and work faster, and you have fewer mistakes and accidents.* Human eyes were meant for outdoor, daylight seeing, yet by actual measurement the brightness of illumination in the sunshine on a clear June day is 2,000 times as much as that in the average living room at night. Utilize the daylight hours for your most strenuous visual work and reduce eye fatigue.

To have adequate light without waste, provide extra lamps for use just where and when you need them. Remember that you need three times as much light to read a newspaper as you do to read a well-printed book.

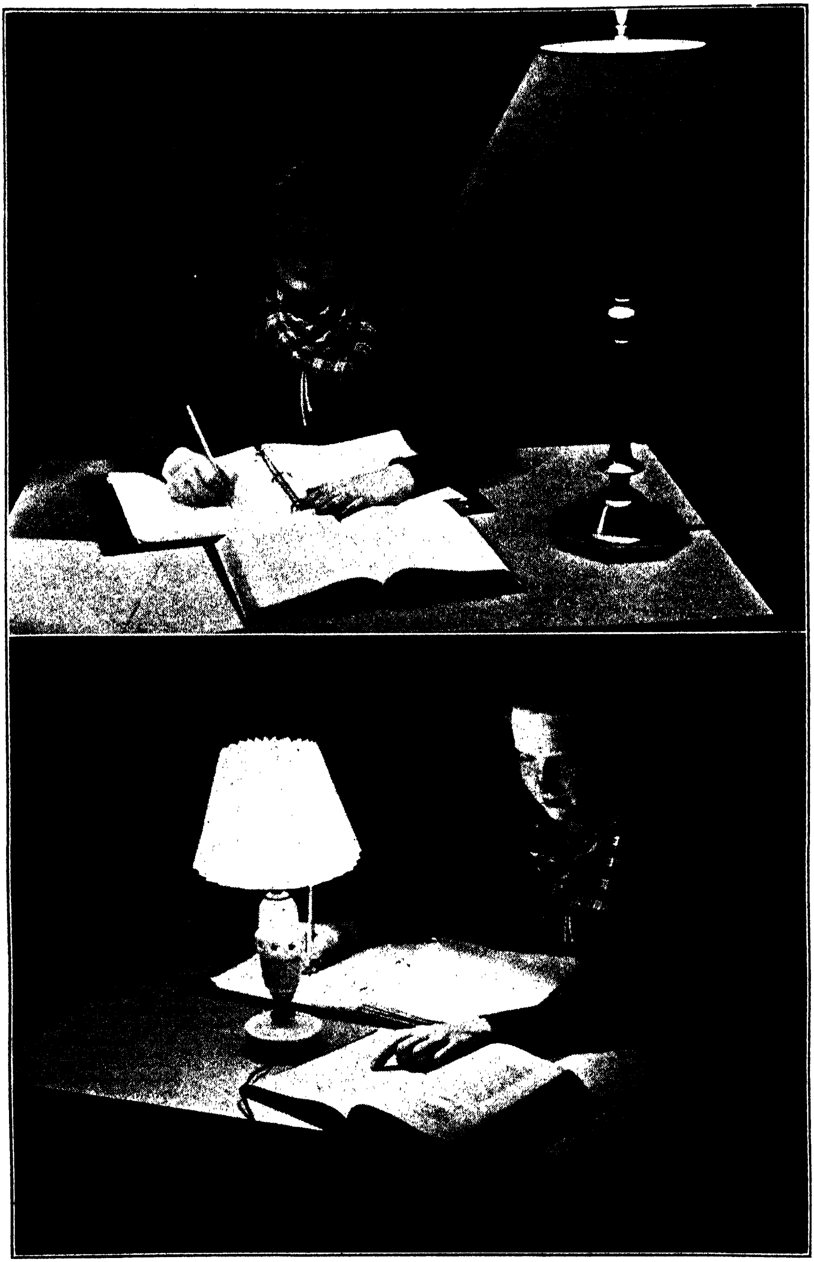
Learn to use your eyes correctly. Most adults have forgotten how to see! Seeing was intended to be the easiest possible process, but most people make hard work of it. They frown and "screw up their faces." Lest they miss something, they stare with eyes wide open instead of blinking easily and often and shifting the eyes about as they did when they were children. You, too, may need to train your eyes patiently back into the good habits listed here:

Habit 1. *Blink often* (several times per minute when reading, riding, or looking at movies). This is scarcely noticeable and does not interfere with seeing. The tears it spreads cleanse the cornea, keep it from becoming dry and irritated, and preserve its brilliance. The muscles also get a brief rest.

Habit 2. *Shift your line of vision — don't stare,* especially when looking at movies. Definitely focus first on one part of the screen and then on another. This prevents the external eye muscles from becoming tense and tired. When doing close work, glance occasionally at some distant object.

Habit 3. *Focus definitely — don't try to see too much at one glance.* For close, accurate work train yourself to fix your attention on a small area and change pictures by moving the eyes. You naturally do this in writing. Do it also while reading. Focus on one word at a time. The muscles can be trained to do this rapidly but you must begin practicing slowly.

Habit 4. *Maintain good posture for eye work.* Reading with the head bent forward interferes with circulation, especially to the head and eyes, causes headaches, and may tend to produce nearsightedness. Viewing work at a sharp angle, as when lying down,



119 *Above.* Light is adequate, diffused, and properly placed. *Below.* Typical eye abuse. Not enough light for close eye work; lamp improperly placed so that its light is reflected into the student's eyes. (Courtesy of Western Institute of Light and Vision)

distorts the image and strains the muscles in their effort to focus. For all reading, sit upright with the book about 14 inches from eyes.

Habit 5. *Use eyes when physically fit only.* When the body is weak, the eyes are especially weak and easily strained. Many people develop eye defects after some illness. Never read or sew when you are ill, overly tired, or emotionally exhausted. Don't "rest by reading," but rest with the eyes closed first, then read for only a short time.

Avoid hazards of eye infection. Many a person has been blinded for life by wiping the eyes on a soiled towel or handkerchief. Other common sources of infection are hands (keep them away from eyes), dust, and cinders. Severe inflammation should be treated by a physician as soon as possible. Mild inflammation may be due to glare, windburn, lack of sleep, insufficient vitamin A, or eye strain from eye defects, faulty use of eyes, or staring. These may be relieved by remedying the cause and using simple eye washes, such as boric acid solution. Eye washes are also helpful in preventing infection from foreign bodies in the eye. If a particle cannot be removed by such eye washes within a few hours, it is advisable that you consult a physician.

Avoid hazards of eye wounds. Never, for a moment, should you run the risk of an eye injury to yourself or others. One careless moment is enough to blind a person for life. Therefore it should be second nature to keep all sharp and pointed things such as scissors, pencils, and fingers away from the eyes. Young children should never have access to dangerous things and older children should be taught how to handle them carefully. Toys and play equipment should be kept free from wires, hooks, and sharp points at all times. Firecrackers and all explosives also are potential sources of danger to the eyes.

As first aid for eye wounds, cover the *closed* eye with a cold wet compress (use boiled water if possible), bandage lightly so as not to press on the eyeball, and *consult a physician at once.* For chemicals such as lime, plaster, cement, or acids, wash out immediately with large quantities of water and see a doctor.

Relax eyes often, especially before sleeping. For this purpose, try the following methods and use one or two that suit you best.

1. Relax your whole body and mind as much as possible (see page 348). Close eyes and let your face muscles and tongue grow limp, letting corners of your mouth come up, as you smile faintly. Feel the muscles relax as the smile spreads upward through your eyes.

2. Gently massage the forehead, temples, and cheeks. The eyeballs should not be pressed but it often helps to put pressure, *carefully*, on the bony framework of the eye socket. For protection, *always have eyes closed while massaging face.*

3. Hold the warm wash cloth over the closed eyes for a few minutes when washing the face.

4. Wrinkle forehead by raising brows. Then frown by pulling brows down. Relax all face muscles and allow forehead to flatten out.

5. Shut the eyelids tightly, then gradually let them go until there is no tenseness in them.

6. *With eyes closed,* look to right until you feel muscles pull, then look to left, up, and down. Repeat several times. Then roll eyes around as if looking as far as possible in each direction. Roll in opposite direction. Then relax.

7. Occasionally, when studying, place the hands over the eyes so that they do not touch the eyes but also do not let in light. Place elbows on a table, head on hands. Let eyes relax, closed.

Exercise eyes to develop and strengthen normal vision. Do some of these exercises each day to keep your eyes strong. If your eyesight is weak or defective, see an eye specialist, wear glasses if he prescribes them, and ask him which of these exercises are best for you. *Important note: Follow directions exactly.*

1. Relaxing eyes with sunshine is becoming a common practice. Improve your sight as follows: Close your eyes, let sun shine directly on them as you turn your head very slowly from side to side for three or four minutes. (Let speed of moving head and length of exercise depend on the brightness of the sun.) When eyes feel relaxed open them for quick glances to the side, but *never toward the sun.* Don't try to see anything, just let a little light in. If you have to *see* things in *glaring* sunlight, as when working or playing, wear dark glasses, but do the exercise without them.

2. Read for a few minutes each day in correct position (see page 313, Habit 4) and blinking about three times to each line.

3. Place two small objects (such as paper clips or marbles) about 3 inches apart on a table approximately 12 feet away. Focus clearly first on one and then on the other so your eyes shift back and forth to get a clear image each time. Blink between shifts. Repeat for closer points until they are almost together. Then use points on the wall separated in different directions. Then relax eyes.

Conclusion. A large percentage of ear and eye defects result from ignorance and carelessness. Hence you should have serious concern for the protection and care of these chief avenues which connect you with the world. Remember to shield them from anything that might infect or injure them.

Some eye defects are due to misshapen parts of the eye and cannot be corrected except by wearing eye glasses. Other defects result from muscular strain, nervous tension, or poor lighting conditions. Many of the latter defects can be cured by correct exercises. All corrective exercises and lenses, however, must be prescribed by an eye specialist in order that they may meet the individual needs, for wrong exercises and lenses are likely to make the condition worse.

ACTIVITIES

1. **Self-check on your study of this problem.** See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. **Training your taste.** Train yourself to like some food that is good for you and that you now do not like.

3. **Experiment on sense of touch.** Have another pupil look away while you place blunt points of tweezers lightly on the back of his hand. Sometimes use one and sometimes two, letting him tell you how many he feels. Vary the distance between the points until the two feel like one to him, then measure the distance between the points. Why doesn't he feel both points? What does this distance represent? Repeat for ends of fingers, palm of hand, upper arm, back of neck, cheeks, and lips. Record results. What do you conclude?

4. **Testing your hearing.** See if you are able to hear the tick of an Ingersoll watch 48 inches away. Why is this method apt to be inac-

Your Health Habits

Check yourself on the following habits. Do you —

a. Keep the mucous membrane of your nose and throat healthy?
b. Avoid blowing your nose too hard?
c. Take every earache seriously?
d. Never read in a moving vehicle?
e. Focus your eyes accurately on a small area instead of trying to see too much at once?
f. Always have an even light on your work?
g. When doing close work, rest your eyes often by looking at a distant object?
h. Always have proper illumination, without glare, for eye work?
i. Avoid worry and other emotional strain?
j. Blink and shift your eyes often?
k. Maintain good posture for eye work?
l. Always keep hands and soiled handkerchiefs and towels away from eyes?
m. Relax eyes often?
n. Use some of the exercises given on pp. 316–317?
o. See an eye specialist and obey him, if you have any suspicion of eye trouble? (Remember, your eyes were meant for you to look *through*, for all of your life, rather than for other people to look *at!*

curate? If your school has a Politzer apparatus or an audiometer,[1] test yourself with these. Why must each ear be tested separately?

5. Testing your eyes. Test your laboratory partner for: (1) color blindness, (2) near- and farsightedness, and (3) astigmatism. Then let him test you. (Get material and instructions from your teacher.)

6. Remedying your eye and ear defects. If you suspect, from tests above, or headaches, or difficulty in seeing or hearing, that you have any such defects, go to a specialist and have a thorough examination. Do what he says.

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[1] For detailed outline of types and purposes of audiometers, see W. C. Phillips and H. G. Rowell, *Your Hearing*, D. Appleton & Co., New York, 1932, p. 37.

7. Key words. Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each:

end organ
olfactory
gustatory
cutaneous
auditory
optic
middle ear
cochlea
semicircular canals
retina
cornea
iris
pupil
aqueous humor
vitreous humor
crystalline lens
ciliary muscle
nearsightedness
farsightedness
astigmatism
cross-eye

SUGGESTED REFERENCES[1]

American Society for the Hard of Hearing, "Hearing Through Life," *Hygeia*, October, 1937.

Berens, Conrad, "It's Smart to See Well!" *Hygeia*, August, 1939.

Haggard, H. W., *Man and His Body*, Harper & Brothers, New York, 1938. (Use index.)

Henderson, Olive G., and Rowell, H. G., *Good Eyes for Life*, D. Appleton-Century Company, New York, 1933.

Meredith, F. L., *Health of Youth*, Blakiston's Son and Company, Philadelphia, 1928. (Use index.)

Phillips, W. C., and Rowell, H. G., *Your Hearing — How to Preserve and Aid It*, D. Appleton & Company, New York, 1932.

Seeing — A Guide to the Best Use and Care of the Eyes, The Western Institute of Light and Vision, Los Angeles, 1938. (This is probably the best single reference on vision. If you do not have this booklet, write for it.)

Thomson, E. S., *Your Eyes and Their Care*, D. Appleton & Company, New York, 1929.

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[1] Use also books in *General References* in the Appendix. Also, for information concerning latest literature, write to American Society for the Hard of Hearing, 1537 35th St., N.W., Washington, D.C., and to the National Society for the Prevention of Blindness, 50 West 50th St., New York.

Problem 18. *How Do Endocrine Glands and Nerves Act as Regulators?*

> Shallow men believe in luck, strong men in cause and effect.
> — EMERSON

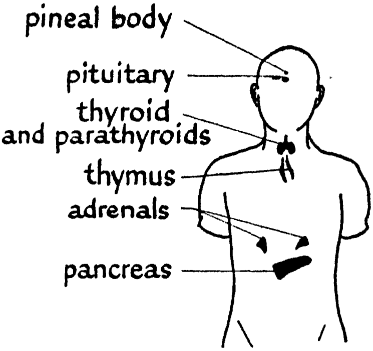
STUDY OUTLINE

A. What each endocrine gland does
   1. Why are a few people dwarfs and a few giants? Could they have been treated to grow normally?
   2. What is a goiter? What is its cause and cure?
   3. Is thyroxin safe to use for reducing? What does it do?
   4. Does glandular unbalance change a person's personality? What glands might be involved?
   5. Why do some animals change color according to background?
   6. What can be done for a child who does not develop normal masculine or feminine characteristics?

B. How glandular unbalance is caused, detected, and treated
   1. What could throw the endocrine system out of balance?
   2. How does a doctor diagnose and treat gland troubles?

C. How autonomic nerves control bodily functions
   1. What is the autonomic nervous system and how does it work?
   2. How can thoughts of anger speed up heart action and interfere with digestion?
   3. What do the sympathetic and parasympathetic nerves do? What do the endocrine glands have to do with them?

IN THE theater of life it is the well-balanced person who is admired and becomes the hero. In a crisis, he does not "lose his head"; in a fight he watches his chance and deals a telling blow. He is always in the right place at the right time and can be counted on to say the right thing. In everyday life, such people are respected for their poise, good judgment, and dependability. What makes the difference between them and the flighty, emotionally unstable, or explosive types of people? What makes some people tall and thin and others short and fat (Fig. 122)?



120 Diagram showing the location of some of the endocrine glands.

Scientific evidence now indicates that the real cause of human differences is a combination of heredity and training, and that these factors work chiefly by means of *endocrine glands.* These glands have been found to hold the secret of the 7-foot giant and the 3-foot dwarf, the intellectual genius and many so-called imbeciles, as well as of all of us who call ourselves normal and come somewhere in between these extremes. These glands register physical balance as health, and emotional balance as poise. Extreme abnormalities result only when something goes wrong in the endocrine system.

The endocrine glands are aided in their control work by the autonomic nervous system. You will want to study this combination of nerves and glands in order to understand better (1) yourself and other human beings, both normal and abnormal, and (2) some of the first symptoms of abnormality.

WHAT EACH ENDOCRINE GLAND DOES

The location of the various endocrine glands, as shown in Fig. 120, has been known since ancient times, yet comparatively little has been ascertained concerning their functions until the last two decades. (Reread page 36.)

The thyroid — regulator of metabolism. The *thyroid* (thī′roid) gland consists of two lobes, one on either side of the "Adam's apple." It secretes a powerful hormone called *thyroxin* (thī-rŏx′ĭn), which regulates the growth and development of both physical and mental functions. The presence or absence, in the blood, of a tiny drop of this wonder-working chemical makes the difference between a normal person and an imbecile. The nerve cells are particularly sensitive to it. Individuals whose thyroids are too active tend to be emotional and temperamental.

A deficiency of thyroxin in infancy leads to a condition known as cretinism (krē′tĭn-ĭz’m), in which both physical and mental growth is stunted (Fig. 121). If treated early, this condition can be remedied by thyroid extract. If the deficiency occurs in adulthood, it produces similar symptoms which can be cured.

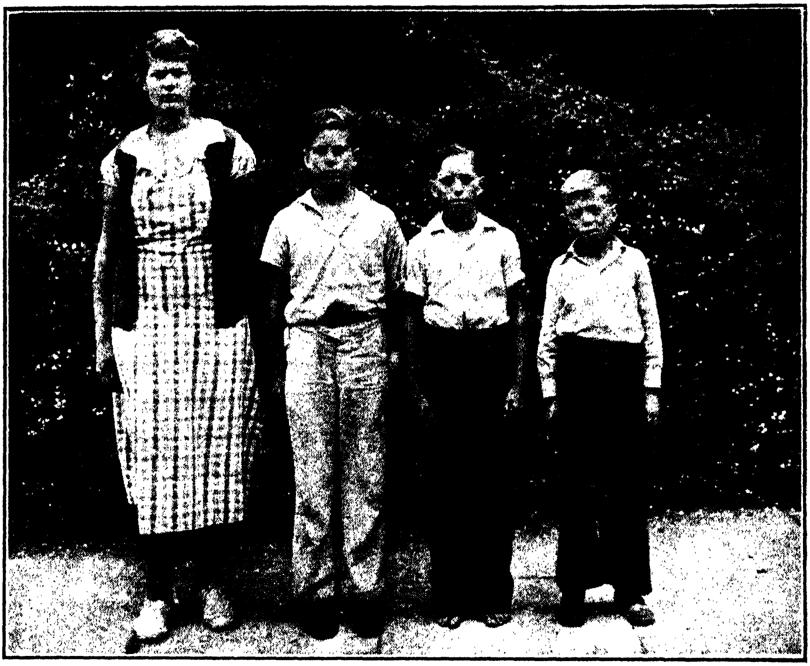
121 A "cretin" 31 years of age, 4 feet 4 inches tall, and with a mental age of 7. This type of feeblemindedness is now preventable in early stages if it is due to underactivity of the thyroid. (Courtesy of Dr. M. C. Montgomery, Rome State School)

When the thyroid is overactive, the person becomes extremely nervous, irritable, and unstable, the muscles tremble, the heart may palpitate, and frequently the eyeballs protrude. This condition is known as *exophthalmic* (ĕk′sŏf-thăl′mĭk) *goiter*. Another form of goiter involving simple enlargement results from underactivity. The chief, though not the only cause of goiter, is a lack of iodine. If the thyroid does not receive sufficient iodine to manufacture thyroxin, it works harder to obtain whatever minute amounts it can. In doing so, it enlarges, just as your biceps muscle does after long-continued hard exercise.

Inadequate work of the thyroid leads to sluggishness, loss of interest in activities, and, finally, to mental impairment; while too much of it leads to nervous irritability. Hence emotional poise depends chiefly upon a normal thyroid gland. On the other hand, healthy functioning of the thyroid demands proper stimulation from the nerves; hence the two are mutually dependent upon each other.

The parathyroids — regulators of calcium. Although these glands are but four tiny bits of tissue imbedded in the thyroids, they are of prime importance to life. If they are removed, death results within 24 hours.

The greatest function of the parathyroids is to help regulate



122 Differences in the action of the endocrine glands, principally pituitary and thyroid, made the differences in these four 14-year-olds. Are you ever guilty of blaming people for individual peculiarities which they cannot help? (Courtesy of Los Angeles Board of Education)

the calcium content of the blood. A proper amount of calcium is necessary for bone and tooth building, for proper nerve action, good muscle tone, regular heart beat, clotting of the blood, and maintenance of the alkalinity of the blood and lymph. Loss of muscle tone is a condition known as *tetany* which frequently occurs from insufficient parathyroid hormone (tetanus is a *different* condition; see page 228). Symptoms of this condition are muscular tremors or spasms, lack of muscular co-ordination, and inability to relax, sleep, or sit still. A single injection of parathyroid extract may temporarily relieve the condition, but a permanent cure requires long treatment.

The adrenals — "glands of combat." These glands are chiefly responsible for the many symptoms of anger and fear — flushed face, pounding heart, void sensation in the pit of the stomach, and extraordinary muscular strength. All of this action is produced almost instantly by the secretion of a tiny amount of *adrenalin* (ăd-rĕn′ăl-ĭn) from two small, pea-shaped glands, the *adrenals* (ăd-rē′nălz), situated one above each kidney.

123 Giantism is caused by an over-secretion of the pituitary gland in early life. The man in this picture is 8 feet, 8½ inches tall. (Press Association)

The adrenals give you strength for crises such as physical injury, cold, drowning, and all situations which arouse fear or anger.[1] In such cases the adrenalin stimulates smooth muscles to contract, thus increasing blood pressure and sending more blood to the skeletal muscles, lungs, heart, and brain. At the same time the liver is stimulated to release more sugar into the blood for fuel. War or any other challenging task liberates in most people an extra quantity of adrenalin, which gives them more energy.

The pituitary — "the master gland." The *pituitary* (pĭ-tū′ĭ-tĕr′ĭ) body consists of two glands in one, the size of a small marble. In many ways it is the most important gland in the body, because it largely controls growth and development. It is located almost in the center of the head, suspended from the underside of the brain, and housed in a saddle-shaped niche in one of the skull bones.

The front or *anterior* lobe of the pituitary controls *growth* (Figs. 123 and 125). Extremes of stature such as that of the circus giant are due to improper functioning of this gland. If it is too active during the stage of growth, the *long* bones grow out of proportion

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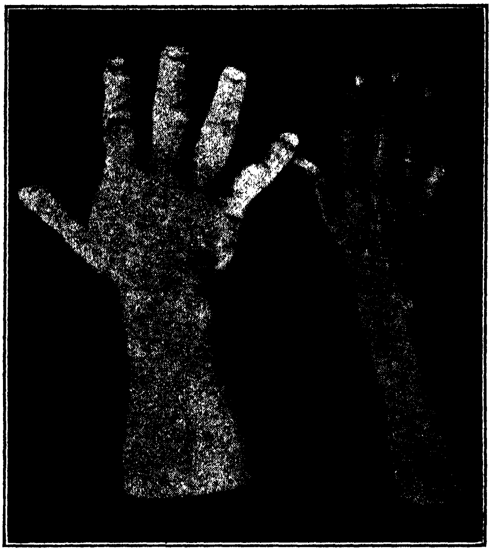
[1] For evidence of the functions of adrenalin and its effects on health, see Problem 21, page 373.



124 *Right.* Hand of a normal adult. *Left.* Same hand after acromegaly had set in (see text). (From Dana's *Textbook of Nervous Diseases*, Williams & Wilkins Co.)

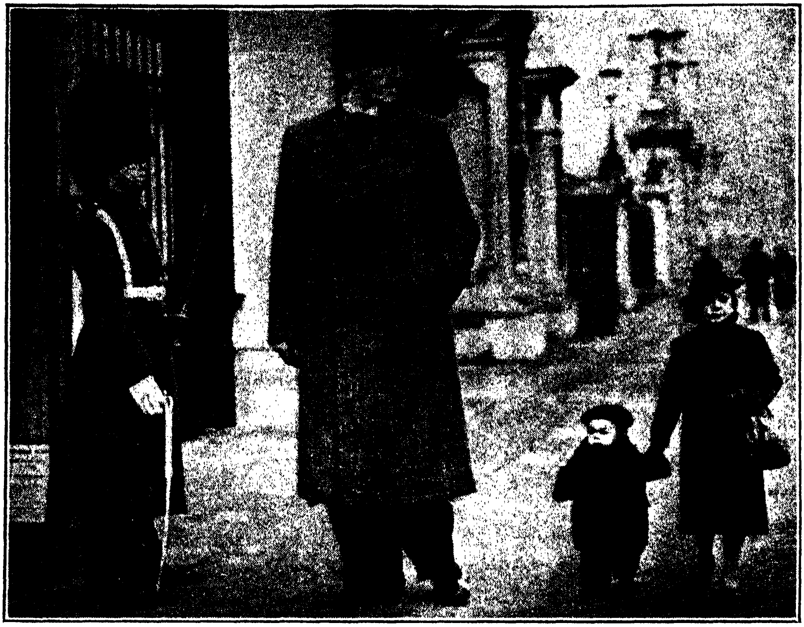
to the rest of the body, thus producing a giant. If the gland is overactive after a person has stopped growing, only certain parts of the body will respond to its stimulus. The victim may develop very large hands, or feet, or lips, etc., and may resemble his former self only remotely (Fig. 124). This disease is known as *acromegaly* (ăk′rô-mĕg′à-lĭ), in contrast to the pure *gigantism* which begins in childhood.

The opposite effect, *dwarfism*, is due to an *insufficient secretion* from this gland during the growing period so that the person attains a height of from 2 to 4 feet only. Other types of dwarfs resulting from different causes, have heads too large or legs too short. Pituitary dwarfs, however, are well proportioned, but simply do not attain normal height. They mature, are ordinarily intelligent, some even brilliant.

If pituitary dwarfism is recognized in early childhood, it may be remedied by injections of pituitary growth hormone. Giantism, however, is more difficult to control, as it is due to an oversupply of this hormone and nothing is known at present which will counteract it.

Of the other pituitary hormones, one is responsible for body weight; if it is oversecreted, fat is used up immediately and the person is extremely thin in spite of adequate food intake. On the other hand, if this hormone is deficient, the body cells store up fat excessively.

Since the pituitary is so intimately connected with the brain, with other glands, and with cell growth, it greatly affects mental



125 This illustration shows giantism (see also Fig. 123) as well as dwarfism. The height of the Buckingham Palace Guard at the left is approximately that of a normal man. (Acme)

ability and alertness as well as physical growth and energy. Increased anterior-pituitary activity has been found to stimulate mentality. On the other hand, as the gland deteriorates, mental power and pleasing personality also disappear.

The back part, or *posterior* lobe of the pituitary, is connected with the brain through a small stem. It probably secretes at least four hormones, although only one, called *pituitrin*, has been isolated. Pituitrin stimulates smooth muscles to contract, thus constricting blood vessels and raising the blood pressure. It also helps to keep the proper balance between the amount of water taken into the body and that excreted so that the blood becomes neither too thin nor too concentrated. This gland is also responsible for the coloring of the skin and permits certain animals, like chameleons, frogs, and some newts, to adjust their coloring to the surroundings.

Glands of development into adulthood. The *thymus* (thī′mŭs) *gland* is located behind the breastbone and covers the upper portion of the heart. It is very active in babyhood and during early adolescence, but shrinks considerably after the first year or two and degenerates as the individual matures. Its chief action seems to be to regulate the growth of the other glands, especially the adrenals, the pineal, the pituitary, and the sex glands. After these have become mature and regulated in their activity, it seems to be no longer needed. *It is extremely important to examine the thymus gland by x-ray prior to child operations*, since death may occur under anesthetic if it has not shrunk properly.

126 Diabetes, a disease caused by insufficient secretion of the pancreas, is treated with insulin. Shown above is one step in the manufacture of insulin. The crude solution, made from the pancreas of animals, is being passed through a paper filter. (Russell Aikins)

Another gland of childhood is the *pineal* (pĭn′ē-ăl) *body*, located between the two hemispheres of the cerebrum. It is not known what purpose this gland serves in the body.

The *gonads* (gŏn′ăds, sex glands) become active in the early teens and cause the changes of adolescence. After these glands start pouring their secretions into the blood stream, the boy's voice deepens, his beard begins to grow, and he develops the usual characteristics of manhood. The girl's hips broaden, her body rounds out, and she takes on the characteristics of feminine charm. Without the proper functioning of these glands boys and girls cannot come into their true heritage as men and women. Modern science, however, is able to aid such cases with the hormones necessary to insure proper maturity.

The pancreas — regulator of sugar combustion. One of the most thrilling achievements of science has been the conquest of the ancient and dreaded disease, *diabetes* (dī′ȧ-bē′tēz).[1] In 1922 three physicians, working together, culminated researches to which hundreds of scientists had given years of devoted effort. They prepared a substance called *insulin* (ĭn′sû-lĭn, Fig. 126), which, together with careful diet, helps the diabetic to lead a fairly normal life. Insulin is a hormone which normally is secreted into the blood by the pancreas, but which is lacking to a greater or lesser extent in the diabetic patient. Hence it must be injected into his blood to make up for the deficiency. Its function is to bring about the combustion of sugar.

Other glands. In addition to the glands specifically mentioned here, 22 organs have been listed which secrete necessary hormones. Among these are the skin, the heart, the liver, and the spleen. Hormones now unknown may be discovered even before this book is off the press, for many things about the human body are not yet known.

The interrelation of glands. This group of controllers of the life processes — the endocrine system — seems to be built on a plan of co-operation, with uncanny checks and balances, which are not yet fully understood. For the most part the glands work together. Indeed, they are so interrelated that when once the balance in any gland is lost, there usually follows a long train of upsets in the other glands, each producing one or more after effects throughout the body.

The interrelatedness and overlapping of functions of some of the glands are revealed, in part, by Table IV (pages 330–331), showing merely the principal functions of these glands. This chart is only for your convenience and easy reference; it is not intended that you shall memorize any of it.

HOW GLANDULAR UNBALANCE IS CAUSED, DETECTED, AND TREATED

It must now be apparent to you that such a delicately balanced system as the endocrine glands is not to be tampered with by any amateur. No gland medicine or treatment should ever be taken except on the advice of an expert endocrinologist. Again, the desirability of seeking such advice early must be apparent, for complications develop fast. The wisdom of the proverbial ounce of prevention here stands supreme.

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[1] Read this story in De Kruif's, *Men Against Death,* Harcourt, Brace and Company, New York.

Common causes of gland disturbances. Although many of the causes of endocrine troubles are not yet fully understood, certain ones are very definitely conceded by all specialists. Various types of dwarfs, cretins, giants, and some feeble-minded cases result from prenatal causes (and are not well determined) or are due to injuries, tumors, or malnutrition in infancy and early childhood.

Disturbances which occur after babyhood may be due to injury through accident or disease, such as whooping cough, mumps, diphtheria, measles, or tonsillitis. Therefore such illnesses should always receive the best care, and the patient should be given plenty of time to recover fully before resuming activity.

Recent researches point to malnutrition as a great contributing factor in improper gland functioning. The thyroid is especially sensitive to nutritional states. In maintaining healthy glands, an abundance of *vitamins in the diet, together with normal quantities of food in well-balanced proportions* for people of all ages, cannot be overstressed.

One of the greatest causes of glandular unbalance is mental maladjustment. Even without experimental proof, most physicians agree that worry can cause illness and that otherwise healthy people have been known to "die of grief." Science has found out that the reason for such things is overstimulation of the ductless glands and that no one can maintain his health unless he either consciously or subconsciously practices mental hygiene. This is discussed in Problems 21 and 22.

How glandular ailments are detected. Every individual should know some of the outstanding symptoms which call for an examination by a specialist. Briefly they are: extreme undergrowth or overgrowth in children; disproportionate growth as of limbs, trunk, head, and facial features in either children or adults; improper sexual development, especially between the ages of 12 and 20; frequent recurrence of severe headaches, nausea, or other disturbance not attributable to other causes; persistent heart palpitations; weakness or exhaustion; sudden and extreme decrease

TABLE IV

Chief Endocrine Glands and What They Do

Gland	*Processes it regulates*	*Effect of too much secretion*	*Effect of too little secretion*
1. *Thyroid* (hormone, thyroxin)	Metabolism (production of energy)	Irritability Nervousness Goiter (several kinds)	Cretinism (dwarf, imbecile) Myxedema
2. Parathyroids (four glands, necessary to life)	Calcium content of blood Resistance to infection	Serious effects (Too much calcium dissolved from bones — they become thin and soft)	Muscular tremors and weakness Insomnia Nervousness
3. Adrenals (two "glands of combat") chief hormones, = adrenalin and cortin (necessary to life)	Blood pressure Contraction of smooth muscle Coagulation of blood Muscular strength in physical emergencies	Bad temper Indigestion and many other disorders	Muscle weakness Mental depression, lack of courage
4. Pituitary (one gland with 2 lobes) "master gland of endocrines" *Anterior lobe* many hormones; 7 singled out at present	Growth of long bones Weight Mental development Development of sex glands Stimulation of thyroid Stimulation of adrenals	Giantism Acromegaly Thinness Extreme mental activity (some prodigies)	Dwarfism Fatness Mental dullness

Posterior lobe Probably 4 or more hormones, *pituitrin* chief	Contraction of smooth muscles Blood pressure (raises) Secretion of milk and urine Balance of water content of blood Coloring of skin	Deep pigmentation of skin	Extreme fatness (circus lady, dull, roly-poly children)
5. *Thymus* (one gland) active in early childhood only	Probably checks over-rapid growth of other glands during infancy and childhood Dangerous to life when giving children an anesthetic (p. 327)	Retarded development, especially sexually	Too rapid development, especially sexually
6. Pineal (one gland)	Not known	Not known	Not known
7. Gonads (two glands in each sex)	Development of characteristics of manhood and womanhood	Overdevelopment sexually	Underdevelopment sexually
8. Pancreas (one gland) Chief hormone, insulin	Combustion of sugar and fat by cells		Diabetes

in mental ability, alertness, or good behavior; tremors and lack of muscular control; extreme sensitivity to what is going on about one; and intense irritability and nervousness.

The diagnosis of glandular troubles requires a thorough examination by a reputable physician. This branch of medical science is so new the layman needs to be warned particularly against quacks who are taking advantage of the spectacular appeal of the subject and of the general ignorance of the public.

The diagnostic methods which the expert physician may employ to detect glandular troubles include the usual general examination *plus* obtaining any or all of these data: measurements of basal metabolism (very important) and mental ability; observations of posture, size of bones and glands, sexual development, muscular control, apathy or alertness, and mental habits and characteristics such as despondency and depression; x-ray and numerous special laboratory tests.

HOW AUTONOMIC NERVES CONTROL BODILY FUNCTIONS

You may wonder how some of the ductless glands are able to produce such swift and widespread results. In many cases the *hormone* in the blood acts directly upon certain *nerves* which bring about the final action. The glands themselves are also stimulated through these same nerves to continue their activity. This intimate relationship of glands, nerves, and body is centered in the *autonomic nervous system.*

The autonomic nervous system. The autonomic nerves and ganglia are outside of the cerebrospinal system and not directly under its control, yet are connected with it. These nerves control all automatic activities such as the heartbeat, breathing, peristalsis, and temperature regulation of the body.

Part of the autonomic nerves are centered in two chains of ganglia, one on either side of the spinal cord and parallel to it. Some of these nerves also come together into a complicated network called a *plexus.* The "solar plexus," just below the stomach, is one of these. Perhaps you have had the experience of being doubled up and temporarily unable to get your breath because of a blow to the pit of the stomach. This was caused by temporary paralysis of the solar plexus.

How nerves balance each other. The chains of ganglia just described send out branches to all the organs of the body. The part of the autonomic system, between the neck and the pelvis, is usually called the *sympathetic system.*[1] The remainder of the system consists of a group of nerves issuing from the medulla of the brain and another from the lower part of the spinal cord. These together form the *parasympathetic system* (Fig. 127).

The sympathetic and parasympathetic nerves form their own check and balance systems on the organs, for the sympathetic nerves act on the organs in one way while the parasympathetic nerves have the opposite action. In general, the sympathetic nerves accelerate the heart, breathing, and other functions which prepare the body for action, while the parasympathetic nerves prepare it for rest and digestion.

How hormones act on autonomic nerves. It seems likely that various hormones affect different parts of the autonomic nervous system, thus indirectly controlling certain organs. This theory appears to be borne out by the fact that various drugs affect one set of nerves and not the other. For instance, adrenalin speeds up the activities controlled by the sympathetic nerves, while narcotics act as if they paralyze this system. It is probable that the entire endocrine system controls the bodily processes, at least in part, by chemical action on various autonomic nerve centers.

Your thoughts and your life processes. Both the ductless glands and the autonomic system are affected by conscious thought. Nerve impulses passing up and down the spinal cord apparently stimulate the autonomic ganglia (Fig. 127). There may even be centers for this system in the cortex of the cerebrum. At least, the two nerve systems are connected closely enough so that the automatic life processes are influenced by conscious states of mind.

As a result of these physical and chemical connections any unbalanced condition of the mind or glands upsets the autonomic system and the internal organs. Accordingly, many cases of func-

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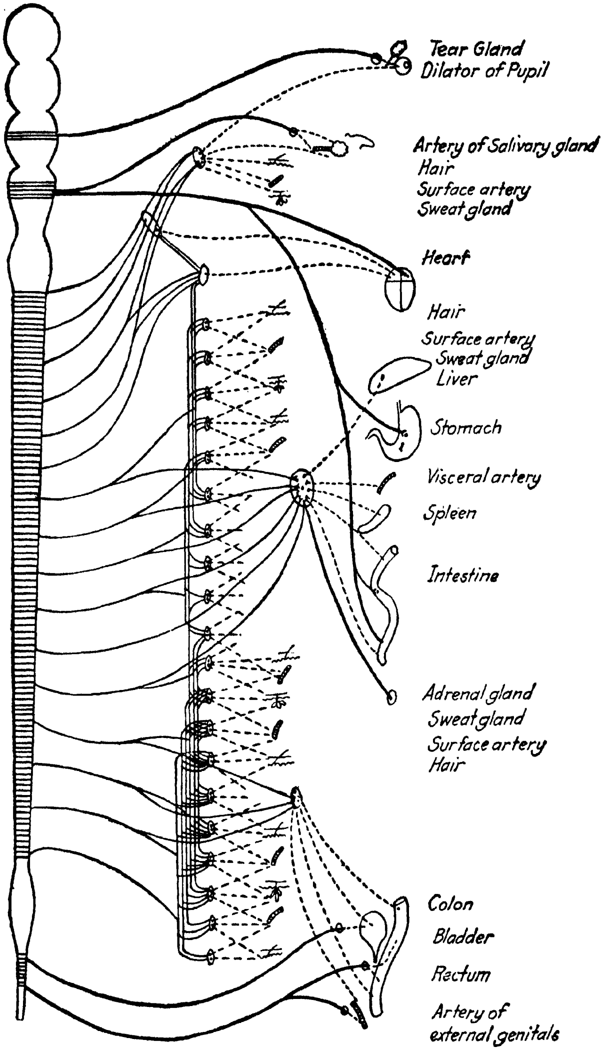
[1] The terminology used by different authors is far from consistent. In reading various texts you should note the definitions each author gives. "Autonomic," "vegetative," and "involuntary" nervous systems usually indicate all the nerves outside the cerebrospinal system. Many confusing terms are used for its subdivisions.



127 Diagram to show the principal connections of the autonomic nervous system with the central nervous system and with various organs of the body. The heavy-lined nerves at the top and bottom of the diagram represent the *parasympathetic* nervous system; all the finer-lined central portion is the *sympathetic* system. The column at the left represents the spinal cord. (From Philip H. Mitchell's *General Physiology*, McGraw-Hill Book Co., after Cannon's *Bodily Changes in Pain, Hunger, Fear, and Rage*, D. Appleton-Century Co., Inc.)

tional disorders of the stomach, heart, liver, pancreas, and colon are now known to be traceable to the endocrine glands or the nervous system. The cure and prevention of such disorders must consist, then, in establishing and maintaining the natural balance and rhythm within the body's three control centers — the voluntary or "conscious" nervous system, the autonomic nervous system, and the endocrine glands.

Summary. The endocrine glands secrete minute amounts of hormones into the blood stream. Some of the effects of hormones are brought about by their direct action on certain cells, while others are due to indirect effects on autonomic nerve centers which regulate body activities such as heartbeat and peristalsis. By these means the glands regulate the rate at which the cells perform all processes of life such as growth, burning of fuel, assimilation of food, and many others.

An extremely delicate balance in gland secretions is necessary if you are to be physically healthy, mentally alert, and emotionally poised. A minute droplet too much or too little of any hormone may upset this balance, as may also mental and emotional disturbances. Gland health requires emotional control and a well-balanced diet with an abundance of all the vitamins and minerals and normal quantities of food.

ACTIVITIES

1. Self-check on your study of this problem. See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. Oral or written reports.

a. The discovery of insulin. This is a remarkable story of scientific co-operation.

b. Some interesting *theories* concerning the relation between endocrine glands and personality types. Be careful and scientific in your reading. (See "How Scientific Are You?" in the Appendix.) Try to distinguish between facts and theories. (See Berman, Louis L., *Glands Regulating Personality*, The Macmillan Company, New York, 2nd ed. rev., 1935.)

c. What clinical workers have learned about glandular cases and "problem children." (See Matteer, Florence, *Glands and Efficient Behavior*, D. Appleton-Century Co., New York, 1935.)

d. Laboratory experiments on the effect of emotions on the body. Choose a few of the many now famous experiments described by Cannon. (See Cannon, Walter B., *Bodily Changes in Pain, Hunger, Fear, and Rage*, D. Appleton-Century Co., Inc., New York, 1939.)

3. A class dialogue. Let one pupil, representing a press reporter, *interview* another, representing a famous endocrine specialist, on some of his most interesting cases, the circumstances and causes which brought them about, and what he did for them. Let the rest of the class take notes and each write up a newspaper story covering the interview.

4. Key words. Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each:

endocrine glands
thyroid
cretin
goiter
parathyroids
adrenals
pituitary
thymus (special precaution?)
gonads
insulin
sympathetic nervous system
parasympathetic nervous system

Your Health Habits

Check yourself on the following habits. Do you —

a. Eat sufficient amounts of *all* vitamins and minerals daily? (See Problem 3 if you have forgotten how to check yourself on this.)
b. Avoid overeating?
c. Avoid emotional upsets?
d. Avoid unpleasantness, for others as well as for yourself, at mealtime?
e. Avoid emotional overstimulation?
f. Avoid the use of drugs except on a doctor's prescription?

Note. Further discussion of the *care* of the entire neuroglandular system will be found in Problems 19, 20, 21, and 22.

SUGGESTED REFERENCES[1]

Diehl, H. S., *A Textbook in Healthful Living*, McGraw-Hill Book Co., New York, 1939, Chap. 18.

Hoskins, R. G., *The Tides of Life*, W. W. Norton, New York, 1933.

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[1] Use also books listed in *General References* in the Appendix and those mentioned in Activities 2 b, c, and d, for this problem.

Unit VII. *Keeping the Controls in Order*

IF YOU were about to buy an automobile, some of the first things you would ask about it are: "How easily can it be handled in traffic?" "How quickly will it respond when I step on the throttle?" "In how short a space can I stop it?" We have learned that such items of quick and accurate control are of primary importance in our modern world. Human beings judge each other by the same standard — "How well do your controls work?"

More and more, life is demanding stronger nerves and greater poise. Already the person with jagged nerves finds that the swift pace and high tension of modern life is leaving him behind. The future calls for stronger and saner men and women than ever before. If you expect ever to be of service, or to make your dreams come true, your greatest and first concern must be to keep your control mechanism of nerves and glands in the best condition possible.

Units VII and VIII will give you suggestions for developing and training your control (neuroglandular) mechanisms. These ideas can be of value to you, however, only if you apply them persistently — and the time to begin is *now*.

Problem 19. *How Can You Keep Your Nerves Healthy?*

> I swear the earth shall surely be complete to him or her who shall be complete. The earth remains jagged and broken only to him or her who remains jagged and broken. — WALT WHITMAN

STUDY OUTLINE

A. The nature and causes of nervous disorders
  1. What are the symptoms of nervousness?
  2. What is the difference between insanity and nervousness?
  3. What causes nervous diseases? Why do some people have nervous breakdowns and others do not, under the same conditions?
  4. How can nervous disorders be prevented? Who must do it?

B. How to overcome nervousness that results from heredity and poor training
  1. What types of nervousness are inherited?
  2. How may people safeguard their children from being neurotic?
  3. How may you strengthen your own nerves?

C. How physical deficiencies and defects may cause nervousness
  1. Why are anemic persons usually nervous?
  2. What food elements are essential for healthy nerves?
  3. What physical defects are particularly hard on nerves?
  4. Do irritations from the environment seriously affect the nerves? What can you do about them?

D. How to rest your nerves
  1. Is sleep a waste of time? Is there a substitute for it?
  2. How does anyone know scientifically that you need to sleep a certain amount? What happens if you don't sleep enough?
  3. Can you always relax? How can you learn to relax?
  4. What can you do to help yourself sleep soundly?

HEALTHY nerves! This is the modern cry. Never before has life placed such a strain upon human nervous systems as it does today. The result is a marked increase in nervous disorders. In no other aspect of personal hygiene do you need quite so much wisdom and clear thinking as in the safeguarding of your nervous system.

THE NATURE AND CAUSES OF NERVOUS DISORDERS

Nervousness may become a habit that grows upon you, but you can do much to prevent or check it. Through ignorance and fear many people who are a little nervous worry about themselves and make their condition worse. Before long they may begin to wonder if they are going insane, and they waste their energy on worry instead of using it constructively for recovery.

The meaning of nervousness. A nervous disorder may result in loss of control of thoughts, emotions, or actions. Since the nerves govern all organs of the body, nervousness may take innumerable forms. It may appear as: "blues," anxiety, worry, fear, irritability, or hopelessness; oversensitiveness to noise, light, or the mental strain of life; slight fidgetiness, tingling, twitching, or trembling of muscles; lack of ability to relax; undue fatigue especially in the morning; or inability to face life's tasks and problems. In more severe cases people suffer from intense depression, fear without reason, strange ideas unnatural to them, strong impulses to do absurd things, sudden emotional storms with little or no provocation, insomnia, or complete nervous exhaustion commonly and erroneously called "nervous breakdown."

Nervousness can also cause the *symptoms* of many other diseases: coughs, indigestion, unsteady heart, headaches, sluggish liver, constipation, muscular aches and pains, and even deafness and blindness. Although the pains and symptoms appear very real, they are caused by nerves — not by the disorder indicated by the symptoms.

The nature of insanity. In its most severe states, nervous disability often develops into insanity which, to an expert, is clearly distinguishable from other nervous states. In most instances of true insanity there is an actual *impairment of the nerve structure.* The condition may be temporary or permanent. With modern

128 Save your nervous system by learning as early as possible the vocation for which you are fitted. This boy is taking a mechanical-aptitude test. Thousands of people are made nervous by being in the wrong kind of work. (Courtesy of Los Angeles Board of Education)

methods of treatment by a specialist (called an *alienist*), some cases are curable, though it may be long, tedious, and expensive. Prevention is simpler since the causes of insanity are fairly well known. They are chiefly (1) heredity, (2) syphilis and other diseases, (3) alcohol and drug addiction, and (4) unhealthy mental habits.

Causes of nervousness. The term *neurosis* (nū-rō′sĭs) refers to a condition in which the nerves do not function properly and in which there is *no* organic nerve impairment. Such nervous disorders may result from either physical, mental, or emotional causes. By building up a strong protective system of physical and mental habits you should be able to avoid such conditions.

The most prevalent causes of nervous disorders are (1) heredity, (2) poor early training, (3) anemia, (4) malnutrition, (5) constant irritation of sensory nerves, especially from physical defects, (6) insufficient rest and relaxation, (7) diseases, particularly syphilis, (8) alcohol, tobacco, and drug addiction, (9) poor mental habits, and (10) glandular disturbances. These cannot all be discussed in a single problem. In fact, items (7) to (10) are of such great importance and far-reaching effects that they are treated separately (see Index).

Predisposing versus exciting causes. There are always two elements working together to produce a neurotic condition: a *predisposing weakness* and several *exciting causes.* The predisposing weakness results from one or more of the fundamental causes listed before. The exciting causes are to be found in the stress of life with its petty vexations, shocks, responsibilities, disappointments, and anxieties. Most people erroneously believe these to be the real causes of nervousness, but the vast majority of people withstand these hardships without mental or physical damage.

Those who blame circumstances altogether fail to recognize that loss of control develops gradually. A nervous disorder seldom comes on suddenly. The final collapse may occur abruptly, but usually there is a long history behind it, often dating back to babyhood or even into one's ancestry. The final circumstance that causes the breakdown is merely the last straw that brings things to a climax.

HOW TO OVERCOME NERVOUSNESS THAT RESULTS FROM HEREDITY AND POOR TRAINING

Anyone who worries over the possibility of having inherited some weakness or bad trait needs education on this subject. Even if he has inherited such tendencies, there is much that he himself can do to help overcome them, unless he is feeble-minded or insane.

The inheritance of nerve weakness. Although nervous diseases, as such, are not inherited, a person may be born with a type of nerves that cannot withstand much strain. Insanity and feeble-mindness are passed on so frequently from generation to generation that the only way of stamping these out seems to be to prohibit people thus afflicted from having children.

The tendency to less severe types of neuroses is now believed to be largely controllable despite inheritance of a weak nerve structure. When children of nervous parents become nervous also, the

129 For healthy nerves develop a hobby — preferably one that takes you out of doors. These boys have raised prize-winning livestock. (Courtesy of Los Angeles Board of Education)

cause is believed to be not their inheritance so much as the "nervous atmosphere" and neurotic habits in which they grow up. It is well, then, for a person with a neurotic family history not to marry someone with a similar inheritance, as this only multiplies the chances of a neurotic home life.

How to train normal or even weak nerves. Guarding and training a nervous child is too serious a task to be explained in a text of this sort. Here we can only indicate the general principles which are of value to older children and adults who wish to help themselves.

You can build the foundations for a healthy nervous system by developing such characteristics as (1) the ability to get along with others in an easy give-and-take manner, to "live and let live"; (2) wholesome attitudes concerning home and social relationships; (3) an understanding of your own abilities and a satisfaction in doing well that which is easily within your own power (Fig. 128); (4) an interest in a vocation and one or more hobbies (Fig. 129); (5) specific skills and habits of honesty, punctuality, faithfulness, and good workmanship which are so essential to vocational success and to the avoidance of an inferiority complex; (6) the ability to look at things broadly and to see through immediate, petty, and vexing circumstances to your greater goal beyond; (7) the habits of good sportsmanship, courage, self-control, a love of play, and the ability to take both defeat and success gracefully, making each defeat a stepping stone to something better; (8) loyalty to high ideals, which is absolutely necessary in order to maintain your self-respect; (9) a good disposition with a sense of humor and the ability to control worry, fears, and other destructive mental habits; and (10) an interest in and a zest for life.

The habits, attitudes and skills just listed form a bulwark against the storms of life, and they may all be acquired through practice. There is no foundation for the common excuses for nerves, namely, "I was born that way" or "I was brought up that way." Even though a child may not have acquired desirable habits of thinking and feeling in early years, modern psychology shows him the way to a strong life instead of a weak one if he will but heed, especially during adolescence.

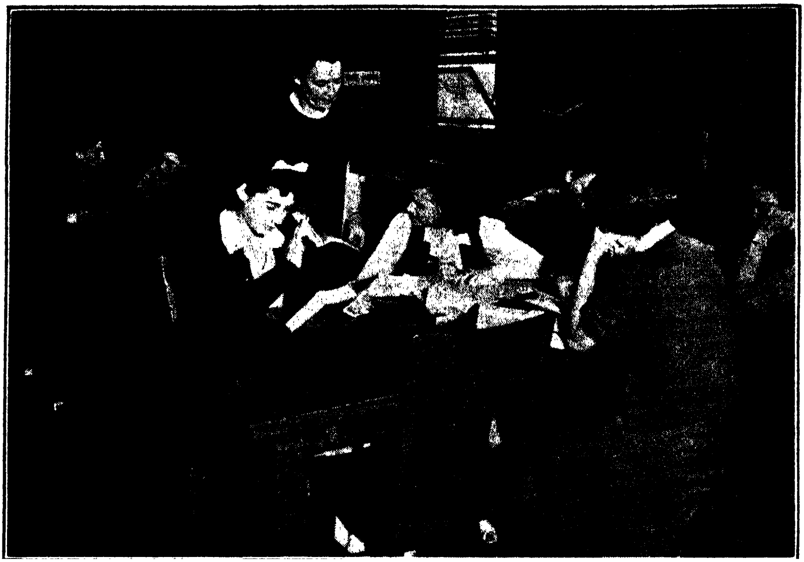
HOW PHYSICAL DEFICIENCIES AND DEFECTS MAY CAUSE NERVOUSNESS

Have you ever been made nervous by a toothache, a headache, a sore toe, or other minor ailment? Any condition that continually irritates any part of your nervous system eventually weakens it all.

Anemia. The nerves are affected immediately by even a slight anemia. A plentiful supply of oxygen seems as essential for the nerves as it is for the muscles. Probably this is one of the reasons why nervous people profit so greatly by being out of doors.

Malnutrition. Just as each type of tissue needs certain food materials to carry on its work, so do nerves require special nutrients, namely, calcium, phosphorus, and vitamin D. In addition to these, the "nerve vitamin" B_1 is also indispensable. Nervous people need extra amounts of it daily. Large quantities of this vitamin have recently been found to cure even certain types of insanity.

Physical defects. Much nervousness results from such seemingly "small" provocations as corns, ill-fitting clothing, fallen arches, defective teeth, tender gums, nasal obstructions, backache, and the like. The sufferer often becomes oblivious to these just because he is so used to them. It is all right to disregard defects if they are only temporary and cannot be helped. It is foolish and un-



130 Cover the hints below and see how many things you can count that are irritating to the nervous system. *Hints:* girl shielding eyes, girl with back to you (what supports her back?), reflections on table, boys talking.

necessary to give undue attention to every minor ache or discomfort, but it is equally wrong to allow chronic irritations to continue when they can be remedied.

Eye strain is by far the most common physical cause of nervousness. You receive more impressions through the eyes than through any other sense organ, and any imperfection in them puts an indirect strain on your whole body. The danger from this type of nervous strain is increased by the fact that you may see perfectly well and feel no pain in the eyes even though the eye muscles have to strain constantly to counteract some structural defect.

More subtle effects occur indirectly, as when a naturally active nearsighted boy shuns sports, becomes a bookworm, and develops a warped personality because, not having glasses, he cannot see well enough at a distance to play active games. It is impossible to estimate the vast number of neurotic cases which started merely from eye defects and which could have been corrected in early childhood.

Irritations from environment. Irritating stimuli come to you through such things as noise, confusion, glaring lights, incompatible personalities, and similar vexations (Fig. 130). No one can avoid all irritating circumstances, but one must learn to ignore them and to bear a certain amount of them. An easy-going attitude toward things you can*not* help will assist you in maintaining poise and emotional stability. Make your environment as nearly perfect as you can without hurting others; but don't let its necessary imperfections fret or bother you.

HOW TO REST YOUR NERVES

Overwork seldom causes nervousness, but the habit of keeping keyed up and tense with insufficient rest is one common reason for jagged nerves. You may begrudge the time you spend sleeping, and wish that some pill would instantly erase the fatigue and let you go merrily on your way. Some advertisers would lead you to believe that certain drinks or cigarettes can perform this very miracle. Scientists have been looking for such a sleep substitute but as yet have found *nothing* that will take the place of even part of your nightly eight or nine hours of sleep, which still remains the most important third of your day. Without it you cannot be truly alive during the other two thirds of the day.

Several scientific studies of sleep have been made. We can indicate here only a few of the most valuable things learned from them.

Why you sleep. Science has shown that the cells of your brain, nerves, liver, and adrenals run down like batteries during wakeful hours, and sleep alone can recharge them. Photographs of fatigued and rested brain cells show this fact. Under ordinary conditions the charging and discharging processes require a definite length of time, which probably explains why sleep is so periodical. Authorities stress the importance of going to bed at the same time nightly in order to overcome insomnia and to develop the habit of going to sleep quickly.

You spend one third of your life in bed in order that (1) the cells of your brain, nerves, liver, and adrenals may recharge while you sleep; (2) your whole body may repay its "oxygen debt" (see page 226) and oxidize the excess lactic acid formed during the day (for this reason fresh air is extremely important for best results from rest); (3) your blood stream may rid itself of wastes through kidneys, skin, and lungs; and (4) your muscles may relax and replenish their store of fuel.

The amount of sleep required. The average adult needs from 7 to 9 hours. Anyone who thinks he can get along on less is probably fooling himself, as actual tests of his efficiency will show. Anyone requiring 10 hours every night is probably physically or emotionally ill and should have a complete examination. Growing children require more sleep than adults. An average of children of different ages shows that the *minimum* sleep requirement (for children) varies according to age, as shown in Table V.

TABLE V *

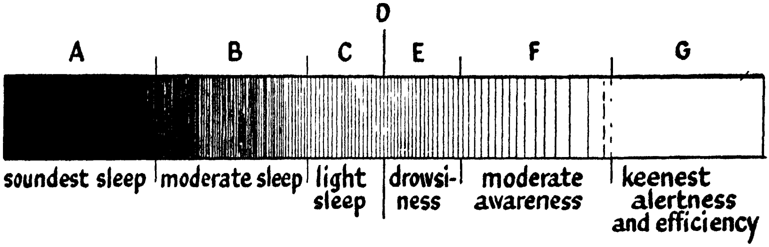
SLEEP REQUIRED

Age	*Hours*	*Minutes*
6–7	11	14
8–9	10	42
10–11	9	56
12–13	9	36
14–15	9	6
16–17	8	30
18–19	8	16

* See Donald A. Laird and Chas. G. Muller, *Sleep, Why We Need It and How to Get It,* John Day Co., New York, 1930, p. 164.

You can judge whether you are getting enough sleep by the way you wake up. If you are in good health and are getting sufficient sleep, you will wake up naturally and feel refreshed. Go to bed early enough to achieve this result.

Effects of loss of sleep. If you do not get sufficient sleep, you pay for it either by making it up later, or by loss of efficiency, or by illness. Professor Laird found that after only 6 hours of sleep college men required 15 per cent more energy to do mental work than after they had slept 8 hours. Insufficient sleep makes it harder for you to understand, remember, and reason. The slowing of reaction time may be positively dangerous and has been the cause of thousands of accidents. Lack of sleep also makes anyone more pessimistic, irritable, and emotionally unstable. According to Professor Laird's results, if you go without sufficient sleep for



131 The degrees of sleep and wakefulness are indicated by shading. The line *D* marks the borderline between sleep and consciousness.

several months you may expect to take a long time to regain your usual efficiency after returning to normal sleep habits.

In an emergency, however, as in caring for the sick or doing other important work, shorter hours of sleep should not seriously impair your well-being. Thousands of doctors, nurses, and mothers have proved that people can lose much sleep and recover quickly *provided they have prepared for it by living normal, healthy lives, and usually having 7 to 9 hours of sound sleep every night.*

Degrees of sleep and wakefulness. People sleep in different degrees; some are sound sleepers and some light sleepers, just as they are alert by different degrees in the daytime. These states of wakefulness and sleep gradually shade into each other as illustrated by Fig. 131. Those who reach the highest alertness and efficiency, at G, seem to be those who prepare for it by the soundest sleep, at A. It appears to be more important to sleep well than long.

The importance of relaxation. Sleep and relaxation should (but do not always) go together. Experiments performed at the University of Chicago and at the Colgate Sleep Laboratory indicate that no one can sleep until he has relaxed to a certain degree and that normal individuals keep on relaxing after going to sleep. Their muscles rest best after several hours, when they have attained their greatest relaxation. For this reason you derive the most good from having 8 or 9 hours of sleep at one time.

Some people find it difficult to relax enough to even go to sleep, while others sleep readily but remain more or less tense all night. They sleep lightly and are apt to be tired and nervous all the time. Usually there is nothing physically wrong with such people; they need merely to *learn how to relax.* Everyone thinks he knows how, but Dr. Jacobson[1] has shown by electric measurement that almost no one knows how to relax unless he has practiced it. Many children become tense during their first school years and lose their natural ability to relax. Often they never regain this ability.

The habit of tenseness is a great cause of nervousness. By interfering with the circulation in the neck and shoulders it produces the typical nervous headache. Because tense muscles are under constant nervous stimulation, you cannot relax the nerves without relaxing the muscles and vice versa. Dr. Jacobson maintains that no one can be nervous in any part of his body if that part is completely relaxed. He has performed some remarkable cures of nervous troubles including spastic colitis (a serious nervous constriction of the colon) solely by teaching his patients how to relax.[2] It is certainly worth while for nervous people persistently to train themselves to relax even though it may take a year or two to master the art.

How to get started right for a good sleep. To sleep well, train yourself to reach a high degree of relaxation before even beginning the night's rest. This gives you a head start on the cells' recovery process, induces sleep more quickly, and allows you to awake more rested and alert. Dr. Jacobson's work indicates that when a person relaxes sufficiently, especially the muscles of the eyes and vocal organs, he cannot help going to sleep.

To free your mind and body from the tenseness of the day, choose from the following suggestions whatever seems to bring quickest and best results for you.

1. Take a short walk, breathing deeply of the fresh air.

2. Spend the last half hour or more before retiring in a quiet way — reading something not exciting, or listening to soft music.

3. Exercise a few moments before getting into bed — especially bending, stooping, or other movements that use the muscles of the lower abdomen, shoulders, and neck.

4. Train yourself to plan the next day before you retire. Write

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[1] Edmund Jacobson, *You Must Relax*, McGraw-Hill Book Co., Inc., New York, 1934.

[2] We recommend that all tense, excitable, sleepless, and nervous persons study carefully and practice diligently the exercises given by Dr. Edmund Jacobson in his popular books, *You Must Relax* (1934) and *You Can Sleep Well* (1938, both McGraw-Hill Book Co., Inc.) or in his more technical treatise, *Progressive Relaxation* (University of Chicago Press, 1938).

down your plans; then put tomorrow entirely out of your mind. Go to bed as if you could sleep all the next day if you wished.

5. Take a tepid bath (92° to 97° F.) for 15 to 20 minutes before retiring. If too hot or too cold, it is stimulating and hinders sleep.

6. Take a warm drink (milk or weak lemonade is good). You may eat something light (crackers or toast), but never anything heavy with it.

7. After getting into bed breathe deeply, pulling the abdomen in and up vigorously each time you *ex*hale and pushing it out and down each time you *in*hale. Repeat 50 or more times — if you can stay awake that long! (This draws blood from the brain and is one of the best sleep producers known.)

8. While falling asleep, relax face and organs of speech by consciously relaxing muscles of lips, cheeks, tongue, and throat. Force yourself to breathe and think more and more slowly. Sometimes it helps to count or to repeat poetry gradually more slowly and faintly. This is especially good for people who repeat conversations and speeches after retiring.

9. Lie in any comfortable position, but best on the face or back, and let go as completely as possible. Try to get the feeling of heaviness, not forcing but letting yourself sink as deeply and heavily as possible into the bed. It may help if you raise one arm or leg at a time and let it fall limp upon the bed. Do likewise with your head to relax the neck muscles. As you do this repeat slowly and sleepily such words as "heavy, heavy" or "peace, peace."

Conditions that help you sleep well. Even though you may start to sleep well and stay asleep all night, many things may disturb and make you tense without waking you. Professor Laird, experimenting in the Colgate University Sleep Laboratory,[1] found that it pays to arrange the bedroom and bed so as to eliminate all possible stimulation of the sense organs. Sounds may be deadened by rugs and drapes. Both sound and light may be shut out and fresh air allowed to enter by placing a heavy screen a few feet in front of the windows. If a screen is not available, a blanket thrown over chairs between the bed and the windows will help. Wall sounds may be diminished by pulling the head of the bed away from the wall.

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[1] See footnote, page 346.

For undisturbed sleep you need a comfortable bed. Professor Laird's experiments show that the luxury of a double-width bed for one person brings the best sleep and that the narrowest bed anyone should sleep on is one which takes a 39-inch mattress. Two persons in a bed do not sleep so soundly, though they sometimes think they sleep better.

The bed clothes should be wide and long enough to tuck in easily, not too tightly, and stay in place all night. For some unaccountable reason green and blue bed clothes and bedroom furnishings have been proved to be an aid to sleep. The correct amount of covering is important in order that the temperature sense may not be stimulated by too much warmth or cold. The bed itself, if ideal, should be flat and not sag in the middle nor vibrate sidewise. It has been found that people work easiest the next day after sleeping on a bed of medium hardness; a hard bed is next best, and a soft bed is least desirable for anyone who cares how he feels the following day.

One who assumes good posture while lying down will avoid cramped muscles and poor circulation. The back should be nearly straight and the legs slightly bent. You cannot be relaxed if you lie stiff as an arrow. Lying on the left side should be avoided by people with heart disease, but there is no preferred position for a normal healthy individual. If you sleep on your stomach or back you will be better off not to use a pillow, but if on your side you may use a soft one of medium size.

The foregoing conditions have been found experimentally to yield the maximum rest for most people, but if you cannot have these now, don't let it worry you, for your own relaxation from within is by far the most important factor in restful sleep.

Conclusion. Since nervous disorders seldom come on suddenly, most of them can be prevented by eliminating the condition *within* anyone which predisposes him to such disorders. (These causes are listed on page 340.) Since proper training and self-discipline can strengthen naturally weak nerves as well as normal ones, such a program of self-development is worth while; modern tension makes it essential for everyone.

Nerves are as much a part of the body as any other organs; hence they require proper physical conditions such as a clean blood supply, proper food, and good circulation. Also, anything that harms one part of the nervous system may harm it all. Therefore, eliminate all irritating physical defects and discomforts and disregard any minor external irritations which cannot be helped.

Since sleep is indispensable for the brain and nerves you should give attention to this necessity.

Your Health Habits

Check yourself on the following habits. Do you —

- **a.** Strive to understand your own abilities and to develop them, just being yourself?
- **b.** Have an interest in some vocation and learn to do it *well?*
- **c.** See through petty vexations to your goal beyond?
- **d.** Have one or more hobbies?
- **e.** Have these work habits: honesty, punctuality, faithfulness, and good workmanship?
- **f.** Bear up well under responsibility?
- **g.** Eat sufficient vitamins and minerals daily?
- **h.** Correct any physical defects or discomforts promptly?
- **i.** Sleep 8 or 9 hours daily?
- **j.** Avoid unnecessary physical and mental tenseness and consciously try to relax?

ACTIVITIES

1. Self-check on your study of this problem. See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. Eliminating causes of nervousness. Note carefully all the things mentioned in this chapter as possible causes of nervousness. List those that may exist in your life, even though they may show no ill effects at present. Start now to eliminate these one by one. *Make a check chart* for yourself and use it (see page 13).

3. Strengthening your defense against nerve irritations. Choose one or two of the nerve-training characteristics listed on page 342 in which you seem to be weakest. Make a *check chart* and start strengthening yourself in these respects (see page 13).

4. Improving your sleeping habits. Keep an accurate record for at least one or two weeks of exactly how long you are in bed each night and about how much of that time you think you sleep. Are you forming good *sleeping habits?* If not, work out an *exact* plan of improvement for yourself and start using it.

5. A check on your sleeping conditions. Examine the room and bed in which you sleep. Are the conditions conducive to sound sleep? If not, improve them in every way you can. (*Note.* Forget the things you can*not* help!)

6. For special study and reports:

a. Special care of nervous children.
b. Neurasthenia — its symptoms, causes, prevention, and treatment.
c. Neurotic personalities and what to do about them.

7. Key words. Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each:

nervousness
insanity
predisposing causes of nervousness
insomnia
relaxation

SUGGESTED REFERENCES[1]

Gulick, Luther H., *The Efficient Life*, Doubleday Doran & Co., Garden City, N.Y., 1928, Chaps. 11, 14, 17, and 18.
Haggard, H. W., *Science of Health and Disease*, Harper and Brothers, New York, 1938.
Jackson, J. A., and Salisbury, H. M., *Outwitting Our Nerves*,* Century Company, New York, 1932.
Kennedy, F., and Stevenson, L., *Your Nerves and Their Control*, D. Appleton & Co., New York, 1928.
Meredith, Florence L., *Hygiene*, The Blakiston Company, Philadelphia, 3rd ed., 1941.
Weschcke, Charles, *Overcoming Sleeplessness*, The Book Masters, St. Paul, 1935.

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[1] Use also books listed in *General References* in the Appendix and references for Problem 15, page 275, and Problem 16, page 292. Especially good ones are also listed in footnotes on pages 346 and 348.

* For advanced pupils and teachers.

Problem 20. *How Do Alcohol, Tobacco, and Drugs Affect Mind and Body?*

> The secret of being loved and respected is to BE, all of the time, what you pretend to be part of the time. — SUSAN M. DORSEY

STUDY OUTLINE

A. How drugs control cell activity
   1. What do medicines do to heal disease?
   2. Are "dope fiends" rare or common?

B. The effects of alcohol
   1. What does alcohol do to the nerves?
   2. Why do some people act more talkative and lively when they have had a little alcohol?
   3. Should anyone drink alcohol to keep from freezing?
   4. How does alcohol affect a worker's efficiency?
   5. How are venereal diseases related to alcohol?
   6. What diseases may be associated with the excessive use of alcohol?
   7. Do habitual drinkers live as long as other people?
   8. How is alcoholism related to insanity?
   9. What concentration of alcohol in the blood is fatal?

C. The effects of tobacco
   1. Is it injurious to breathe tobacco smoke?
   2. Why are smokers nervous when they don't have tobacco?
   3. Does tobacco affect one's ability to learn?
   4. Why should anyone, especially when young, not smoke?

D. Facts about other drugs
   1. What do opium, morphine, and heroin do to a person?
   2. What habit-forming drugs are found in medicines?

E. Drug addicts
   1. How do people commonly become drug addicts?
   2. Can drug habits be cured?

IN SPITE of "civilization," humanity is slowly being drugged! Human beings pride themselves on their power to control their lives intelligently, yet appalling numbers of them are becoming slaves instead of masters — slaves to some drug. Little by little these substances take over the controls of the nervous system so that the victim reaches for more and more, either to pep him up or to calm him down.

Extensive and misleading advertising campaigns by tobacco manufacturers, liquor companies, and patent-medicine producers have resulted in the excessive use of their products. What is the truth about these products? What can we believe? This problem attempts to give you the answers in a purely scientific manner. The discussion therefore is limited to facts proved in the laboratory or indicated by data gathered by competent investigators.

HOW DRUGS CONTROL CELL ACTIVITY

If you ever use a drug, do you have any idea how it affects you? Drugs act upon some or all of the body cells to change their natural rate of activity. Some drugs speed up cell activity and are called *stimulants*, while others deaden the cells and are called *depressants* or *narcotics*. Drugs that are used to relieve pain, relax nerves and muscles, and produce sleep during a surgical operation are called *anesthetics*. Any drug that produces a harmful effect is said to be *poisonous* or *toxic*. Nearly all drugs are dangerous to life if taken in large enough doses.

Why drugs are used as medicine. All illness is due to a disturbance of cell activity. In diagnosing a case, the physician must determine which cells are inactive or overactive. He then prescribes a drug or other means of treatment that will help restore the sick cells to their normal activity. It sounds simple, but great skill is required to determine the drug or combinations of drugs that will produce the desired reaction in certain cells *without injuring any other part of the body.*

The meaning of the term "dope fiend." The effects of certain drugs, when used for other than medicinal purposes, are vicious. Such a drug affects the nervous system in such a way that after persistent use for some time the user may be in physical and mental agony when he does not have it. He therefore begins to feel that he *must* have it. When anyone has acquired the habit of using a drug to the extent that he cannot completely stop its use by his own will power, he is known as a *drug addict*, or a "dope fiend."

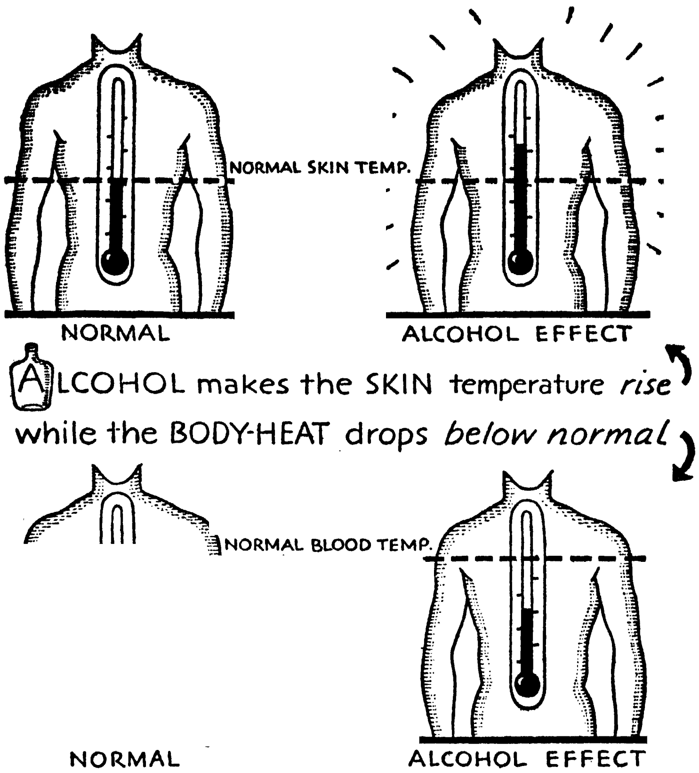
This power of producing addicts is the most dangerous quality of drugs. Although the time necessary to produce this effect depends on the individual and the drug, it is stated in the Report of the Special Committee of the U.S. Treasury Department that "Anyone repeatedly taking a narcotic drug over a period of 30 days, in the case of a very susceptible individual for 10 days, is in grave danger of becoming an addict." Hence, for your own protection, you will want to know about the *habit-forming* narcotics and stimulants that are discussed in this problem.

THE EFFECTS OF ALCOHOL

The erroneous belief that alcohol is a stimulant and that it makes a person warm is commonly accepted because alcohol is "the great deceiver." Its outward effects are directly contrary to the real results it produces behind the scenes. These false effects result from the action of alcohol upon the body's control system. To keep your thinking clear on this subject, distinguish carefully between the immediate momentary effects of alcohol and those resulting from its long-continued use.

What happens to alcohol in the body? When alcohol reaches the stomach, the blood immediately begins to absorb it without any chemical change. Within three or four minutes its presence in the blood can be detected by chemical analysis. Since the body has no way of storing it, alcohol must remain in the blood until it is burned in the cells or eliminated in the breath and urine. The body is capable of burning less than one tablespoon of alcohol per hour, hence if any larger quantity is taken it continues to circulate in the blood for a number of hours.

How alcohol depresses nerve activity. For centuries people believed that alcohol was a stimulant, but science has now proved that it is a depressant and acts as a narcotic in the body. Its irritating effect may have impressed itself upon you sometime when you got a little alcohol into an open cut. Nerve cells are particularly sensi-


NORMAL SKIN TEMP.
NORMAL
ALCOHOL EFFECT
ALCOHOL makes the SKIN temperature *rise*
while the BODY-HEAT drops *below normal*
NORMAL BLOOD TEMP.
NORMAL
ALCOHOL EFFECT

132 Alcohol raises the skin temperature but in excessive amounts it actually lowers the body temperature. (From Bogen and Hisey's *What About Alcohol?* The Scientific Education Association, Angelus Press, Los Angeles)

tive to this irritation. Even a very small amount of alcohol in the blood interferes with normal nerve activity. Its long continued excessive use results in a degeneration of nerve tissues. A concentration of some 0.7 per cent of alcohol in the blood results in death.

By depressing nerve synapses and nerve centers, alcohol profoundly affects the body controls. In this manner it (1) depresses the working of the internal organs [1]; (2) slows a person's reaction to sense stimuli; (3) makes muscular activity weaker and less coordinated; and (4) decreases the ability to think clearly, to judge wisely, and to exert self-control. This last effect causes people to

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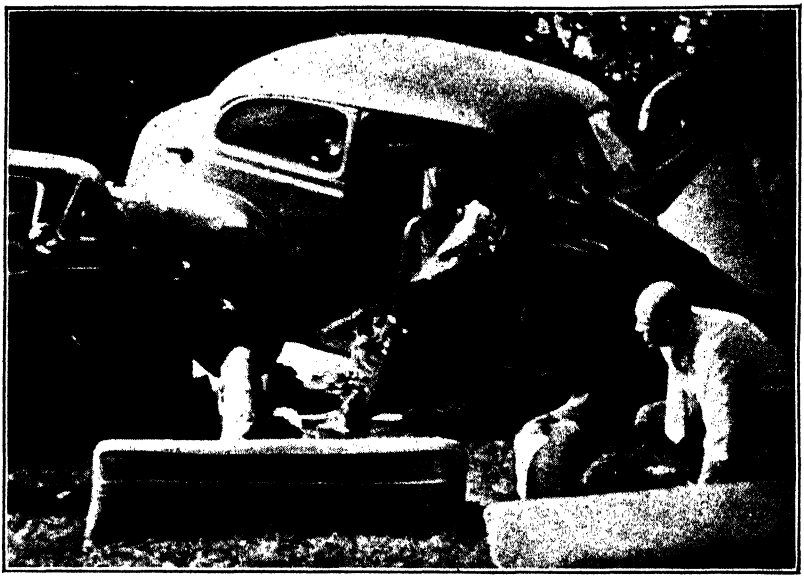
[1] Large amounts of alcohol may have serious results — even death. Read again how it acts upon the heart, page 146.

133 Much modern activity requires extremely steady hands. Alcohol unfits anyone for accurate work.

talk more freely because the brakes have been taken off their good judgment.

Deceiving temperature effects. Indirectly, the blood vessels are noticeably affected by alcohol. Without proper nerve control, which is decreased by alcohol, the blood vessels in the skin dilate causing perspiration and a false sense of warmth. Hence it is unwise to use alcohol before or during exposure to cold, for heat is lost through the skin and the *temperature of the blood is actually lowered* thus reducing the resistance to cold (Fig. 132).

Alcohol and nutrition. Alcohol has *no nutritive value.* It supplies caloric needs but does not supply minerals, vitamins, or proteins. It crowds out these necessary elements of diet. Here is one of the



134 Nobody should drink before driving a car or truck. Lack of co-ordination may cause serious injury to yourself and others. (Press Association)

most serious physiological effects of alcohol and one not usually sufficiently emphasized. It is because of this that vitamin deficiency diseases are so often associated with chronic alcoholism.

The effect of alcohol on mental and physical efficiency. The partial or complete paralysis of nerve cells in the sense organs and higher brain centers by alcohol constitutes a dangerous handicap. Proof that persons are less efficient in many ways after taking small amounts of alcohol is now furnished by a vast accumulation of consistent data on such experiments as the following:

a. Typists were found to be slower and less accurate for more than two hours after a small drink of alcohol.[1]

b. An experiment on 31 athletes in a 100-meter race showed that a small quantity of alcohol taken by some of them 4 to 6 minutes before the start reduced their performance considerably. Those who had no alcohol averaged about two-tenths of a second less time for the run than the others.[2]

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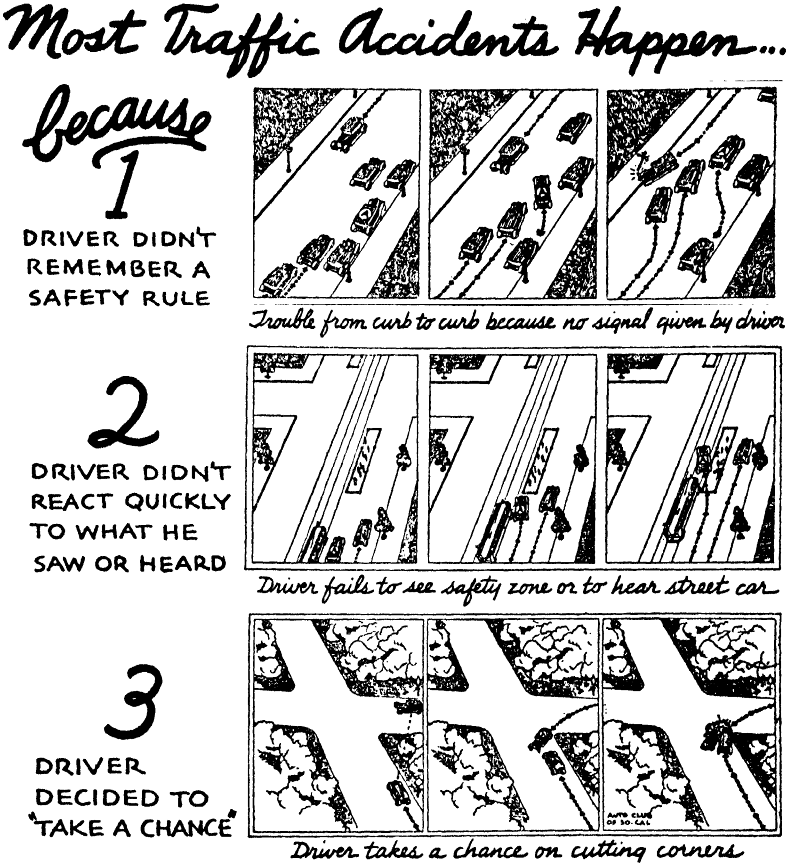
[1] W. R. Miles, *Alcohol and Human Efficiency*, Carnegie Inst., Washington, D. C., 1924.

[2] Experiment by Herxheimer. See J. F. Williams, *Personal Hygiene Applied.* 6th ed. Saunders, Philadelphia, Pa., 1937, page 277.


Most Traffic Accidents Happen...
because
1
DRIVER DIDN'T REMEMBER A SAFETY RULE
Trouble from curb to curb because no signal given by driver
2
DRIVER DIDN'T REACT QUICKLY TO WHAT HE SAW OR HEARD
Driver fails to see safety zone or to hear street car
3
DRIVER DECIDED TO "TAKE A CHANCE"
Driver takes a chance on cutting corners
AUTO CLUB OF SO. CAL

ALCOHOL DULLS THE MEMORY (1), SLOWS REACTION TIME (2), AND WEAKENS THE JUDGMENT (3)

135 (From Bogen and Hisey's *What About Alcohol?* The Scientific Education Association, Angelus Press, Los Angeles)

In addition to the facts above, investigators report that the people experimented upon have *thought* they were doing better after taking alcohol. This is because a person's judgment is impaired by the presence of alcohol in his blood. Hence in small doses, it acts like a mild sedative, producing a false sense of well-being. You can readily see the danger of this deceiving effect, for a person who is engaged in important work imagines that he is acting brilliantly when he is really being stupid and foolish. He is convinced that he can reason, work, and react better and faster when actual tests show that his faculties are impaired. This effect accounts for the appalling number of traffic deaths directly attributed to alcohol.[1]

Alcohol and immorality. Under the influence of alcohol, mind and body are in exactly the same condition as a car without brakes — out of control. No one can trust himself in delicate situations after taking even a small amount of alcohol. People who have had just enough to make them "feel good" and to give them the "I don't care" attitude do things they would never even consider otherwise — things which may cause a lifetime of regret.

Alcohol, even in moderate amounts, is the strongest known cause of weakened self-control. Tragedy in many forms comes to those who do not control the emotions arising from the mating instinct. One of the worst penalties is venereal infection. In this connection Professor Emerson says that "more instances of syphilis and gonorrhea in youths of both sexes, . . . have been due to alcoholic abuse than to any other cause."

Chronic alcoholism and organic diseases. Before anyone runs the risk of acquiring the alcoholic habit he should know what it may do to various organs of his body over a period of years. The habitual use of alcohol is frequently associated with various serious diseases.

The habitual use of excessive amounts of alcohol results in many persons in a condition known as *gastritis* or an inflammation of the lining of the stomach. This condition may be associated with pain after eating, marked loss of appetite, and vomiting. The most common physical disturbance of chronic alcoholism is a change in the liver, usually referred to as *fatty infiltration.* The liver is swollen and its cells are gorged with fat instead of the glycogen stored in normal liver cells. Similar liver conditions occur in diabetes and in starvation. Liver cirrhosis also occurs more frequently in heavy drinkers than in abstainers and moderate drinkers.

Chronic alcoholics suffer from a marked degree of deficiency in the various B vitamins. As a result, they may develop pellagra,

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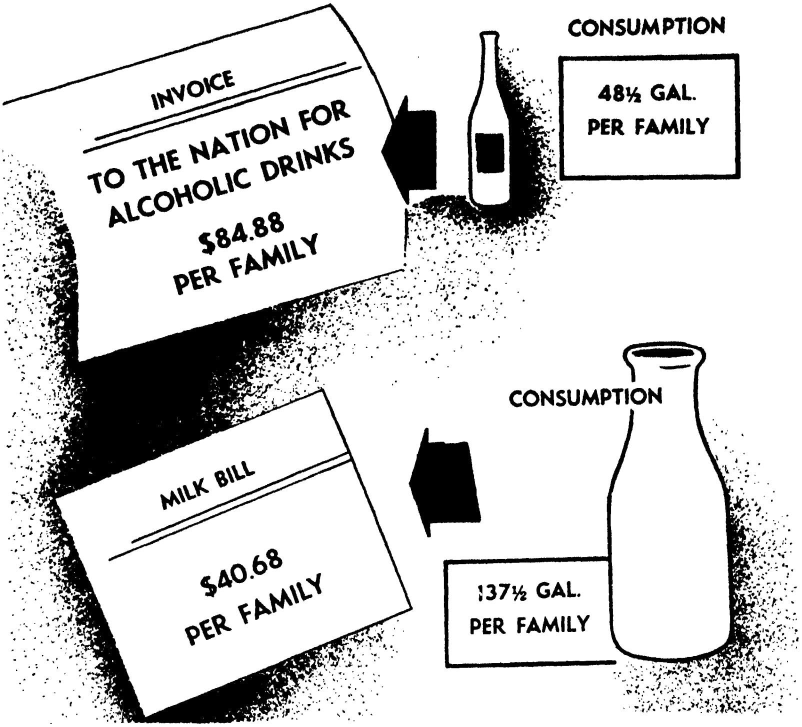
[1] Since the sale of liquor has been legalized, South Dakota reports a 40 per cent increase in auto accidents.



136 Statistics for 1938 showed the facts illustrated above. Such facts can be accounted for only by ignorance of the truth concerning the physiological effects of alcohol and milk. (From *The Alcohol Problem Visualized,* The National Forum)

beriberi, and other nervous disorders, just as anyone else does who suffers from these deficiencies.

Chronic alcoholics may also suffer from burning sensations on the soles of the feet and pain in the legs, once always termed neuritis, which is an inflammation of a nerve. It is now known that these symptoms are due, not to inflammation of a nerve, but rather to the general breaking down or withering of a nerve, as the result of vitamin deficiency.

The general health of the chronic alcoholic is poor. His poor physical condition predisposes him to some serious diseases, particularly to pneumonia or heart disease. It also lessens his chances for recovery when such diseases are contracted.

Alcohol and the average length of life. Careful studies of the records of Life Insurance companies show that heavy drinkers do not live as long, on the average, as do non-drinkers. Similar careful studies to date do not indicate that there is appreciable difference in the average length of life of moderate drinkers and non-drinkers. You will find an excellent presentation of the evidence on this topic on Pages 196–204 of *Alcohol Explored* by H. W. Haggard and E. M. Jellinek.

The alcohol habit and mental disease. The excessive and long continued use of alcohol may end eventually in mental disorder. It is very difficult to show conclusively the exact percentage of all cases of mental disorder that are associated with alcoholism. However, it has been established that there is a connection between alcoholism and some types of mental disorder.

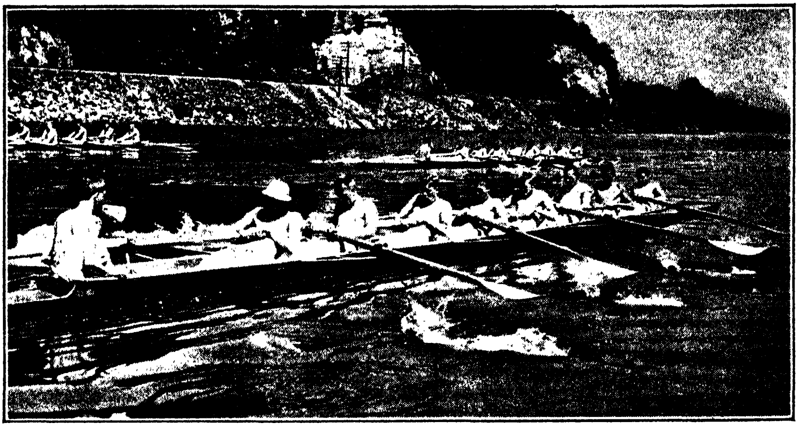
It may be said that about one in ten chronic alcoholics develops an alcoholic mental disorder and requires hospital treatment. This high rate of mental disorders among chronic alcoholics suggests the seriousness of excessive use of alcohol.

Modern scientific studies seem to indicate that persons of unstable nervous make-up are more prone to become alcoholic addicts than are normal persons. This suggests that alcoholism may be, at least in many cases, the result rather than the cause of mental disorders. However that may be, the evidence is overwhelming that the excessive use of alcohol is frequently associated with severe nervous disorders.

THE EFFECTS OF TOBACCO

The tobacco habit is acquired more easily than most other addictions. It takes intelligence, independent thinking, and the courage of your convictions to refrain from smoking in this day of high-pressure advertising. No great amount of money has been available for scientific research on the effects of tobacco, but such laboratory data and statistics as have been accumulated indicate the conclusions presented in this section.

Poisons in tobacco smoke. A number of drugs have been found in tobacco and its smoke. The most active among these is *nicotine*. In its pure form it is an oily liquid, a single drop of which applied to a rabbit's skin will result in death.



137 Alcohol and tobacco weaken endurance and disturb co-ordination. Athletes in training are required to abstain from both. (Acme)

Tobacco and nervousness. When cigarette smoke is inhaled, the poisons come in contact with from 800 to 2,000 square feet of delicate lung tissue and are readily absorbed by the blood. In spite of the fact that the smoke contains only minute amounts of the poisons, the smoker's nerves cannot escape more or less of their toxic effects. The immediate results vary with the individual and his condition. In some cases it produces a "soothing" effect; in others it acts as a stimulant, making one nervous and irritable, and supersensitive to noises, light, and other stimuli. Addiction to tobacco occurs rapidly, and a person becomes increasingly dependent upon its use to keep from feeling nervous.

In actual experience, employers have found that smokers are unable to do many kinds of delicate work that require steadiness and precision. The modern business world is aware of the manner in which smoking decreases efficiency. This is evidenced by the fact that many industrial concerns have established restrictions upon the use of tobacco by their employees.

Effects of tobacco on the heart and circulation. During smoking, the efficiency of the heart is reduced and there is a definite lowering of the temperature of the skin, particularly of the hands and feet, because of circulatory disturbances. Long continued excessive use of tobacco may result, in some persons, in a chronically lowered heart efficiency, palpitation of the heart, rapid and irregular pulse, and shortness of breath. There is evidence that the excessive use of tobacco may bring on an attack of severe pain in the region of the heart in some individuals.

These effects of tobacco on the circulatory system may help to explain the fact that smoking reduces one's general muscular efficiency, endurance, and skill in physical activities. Smoking just before participating in an athletic contest handicaps the player and may contribute to his defeat.

Throat irritation from smoking. The combustion products of tobacco cause the mucous lining of the mouth to become red and dry. Inflammation of the throat, coughing, and chronic hoarseness are common results of using tobacco, regardless of the brand used or of advertising claims to the contrary.

Effect of tobacco on infants. Data have not been compiled which will give conclusive evidence as to the effects of smoking on offspring. It seems conceivable, however, that a prospective mother who smokes is running the risk of poisoning her unborn babe. Future research may reveal the facts concerning this question.

FACTS ABOUT DRUGS

Numerous drugs affect the nerves in such a way as to be habit-forming. Space permits only brief mention of the commonest of these.

Opium and its derivatives (*morphine*, *heroin*, and *codein*, kō′dē-ēn). Opium is a powerful depressant which causes rapid degeneration of the mind. It is responsible for a large number of cases of insanity. An addict will commit all manner of crimes in order to obtain his drug. Morphine is about 10 times as strong as opium, and heroin is 20 to 25 times as powerful. The morphine habit is often acquired unintentionally when the drug is taken to relieve pain. Physicians accordingly use great care in prescribing it.

Marijuana (mä′rē-hwä′nä, Mexican "loco weed"). This is a powerful stimulant that is fast becoming a dangerous enemy of American youth — largely because of their ignorance of it. Anyone who knows about it is afraid to risk even one experiment with it, for it is said that only two cigarettes are sufficient to enslave anyone as an addict. It causes serious derangement of the central nervous system; its victims often become crazed and commit terrible crimes. Its continued use often leads to insanity.

Common drugs in medicines. When a competent physician prescribes a medicine for you and you follow his directions exactly, you need not be concerned about the contents of the medicine. Self-treatment, however, is *always* risky, and often costly, both in dollars and in health. You cannot be sure of your self-diagnosis, and the medicine you select may be useless, or it may merely kill the pain while the real cause grows worse. Or, the medicine may even contain a drug to which you will unwittingly become addicted.

Patent medicines often contain alcohol and opium derivatives, or some lesser yet harmful drug. The commonest and most dangerous of these is *acetanilid* (ăs′ĕt-ăn′ĭ-lĭd), and other related coal-tar products such as *antipyrine* (ăn′tĭ-pī′rĭn), and *phenacetin* (fĕ̇-năs′ĕ̇-tĭn). These are cheap and dangerous depressants used in many headache and cold remedies. *Amidopyrin* (ăm′ĭ-dō-pĭr′ĭn), or *pyramidon* (pĭ-răm′ĭ-dŏn) destroys white corpuscles in certain people and was responsible for 1,300 deaths in the United States in the three years of 1936–1938. The only safe course is to avoid all medicines containing it.

Phenobarbital (fē′nŏ̇-bär′bĭ-täl) and other barbital preparations are depressants used in sleeping pills and powders. *Calomel* should be avoided in laxatives because it is hard on the liver. Some relatively safe, but habit-forming drugs in common use are *acetyl salicylate* (ăs′ĕ̇-tĭl săl′ĭ-sĭl′ă̇t, or aspirin) for headaches, *quinine* (kwī′nīn) for fevers, and *Epsom salts* as a cathartic. Even these drugs, however, should be used only rarely and on a physician's advice.

Hints on buying medicines. Many patent medicines have no remedial qualities. Those having any effect usually contain some of the common drugs mentioned above. All new products should be shunned at least until they have been investigated by the government. Even government approval means only that the product is harmless when used properly and is not falsely labeled. Fortunately, the law requires that the names of the active drugs contained shall appear on the label. *Always read the entire label carefully.*

ADDICTION TO DRUGS AND ALCOHOL

In the great majority of cases, drug addicts are victims of circumstances that they might have overcome had they been on guard. To protect yourself you should know the commonest ways in which people become enslaved by drugs.

Why some people become addicts. 1. *To be sociable.* To avoid being conspicuous, many persons take a cocktail or a cigarette once in a while at the homes of friends and thus gradually form the habit. But is it necessary or smart for anyone to dull his wits just because others do? Is it good etiquette for a host or hostess to insist on a guest taking narcotics? And, should a person have to apologize for refusing to harm his own body? Think through these questions.

2. *To camouflage nervous embarrassment.* Don't delude yourself into believing that drinking or smoking is an adequate substitute for the cultivation of a good personality. Friendship and fun are far more satisfying without an artificial icebreaker or a social crutch to lean on. Lady Astor once said, "When I have a good time I want to know about it."

3. *To satisfy curiosity stimulated by association with bad company.* Recent studies show that probably 75 per cent of new drug addicts are made as a result of contact with undesirable characters. Young people who are willing to try anything once are easy victims to the drug habit.

4. *To get rest during periods of physical or mental strain.* People who take stimulants to keep them going or depressants to enable them to relax, often become addicts before they realize what has happened. Make up your mind to solve your problems without the use of any habit-forming drugs.

5. *To relieve pain.* Many patent medicines merely dull pain sensations by drugging, and do not correct the cause.

Can addicts be cured? Moderate users of alcohol who have sufficient will power can stop drinking, but self-cure is almost impossible for chronic alcoholics. Fortunately, treatments given in institutions can sometimes effect a complete cure, but it is difficult to persuade an alcoholic to submit.

Most tobacco users think they can quit until they try it. The tobacco habit is considered more difficult to cure than alcoholism. Persons with strong will power, however, can cure themselves if they are willing to stand a few weeks or months of irritability. The most important factor is persistent determination to stop smoking plus thorough cleansing of the blood by breathing fresh air, drinking extra water and fruit juices, sweating freely, and eating large quantities of fruits and vegetables.[1]

Cure of addiction to the more powerful drugs such as opium and marijuana requires treatment in institutions. Breaking drug habits acquired from taking patent or other medicines may require the aid of a physician. In any event, the patient must make up his mind to "grin and bear it" for a more or less difficult period of physiological readjustment. *All drug habits are far easier to avoid than to break.*

Conclusion. No one can tell beforehand whether he will become addicted to a certain drug. It is easier to refuse it the first time than ever again. Anyone who uses any narcotic drug, alcohol, or tobacco for a few days runs the risk of becoming addicted. Before taking such a risk, weigh carefully all the known and possible effects upon yourself, your family, and your future children. (The discussion here did not even touch upon the social and economic effects — only the physical ones.) Decide for yourself if the possible gains will be worth the price you will probably have to pay.

ACTIVITIES

1. Self-check on your study of this problem. See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. Experiment on effects of alcohol. Place the white of an egg in a test tube, some bits of raw meat in another, and some pieces of sheep's brain in another. Add alcohol. Watch results. What do the results show about the effects of alcohol on human tissues?

3. Experiment on the effects of tobacco. Obtain some nicotine from someone who smokes a pipe, thus: After the pipe has been smoked and emptied, wipe the bowl out with a clean cloth or cotton. Dissolve out the nicotine by squeezing the cloth in some water. Put a small goldfish or tadpole in the water. Watch results. Put some nicotine on some plant lice and watch results. Is nicotine poisonous to protoplasm?

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[1] For further suggestions see Wm. S. Sadler, *Essentials of Healthful Living*, The Macmillan Company, New York, 1925, p. 187.

4. An experiment on tobacco and heart rate. Count accurately the pulse rate of some habitual smoker, at least three hours after he has smoked. Then have him smoke one cigarette and count his pulse again. Repeat one hour later (no smoking in the meantime). What effect does one cigarette have on the heart? How might this effect, continued over a period of years, permanently weaken the heart?

Your Health Habits

Check yourself on the following habits. Do you —

a. Refuse drinks, candies, pills, etc., that contain unknown substances?
b. Read carefully the labels on all patent-medicine bottles?
c. Seek advice from a physician concerning your ailments rather than use self-medication?
d. Refuse to "try anything once" if it is of a questionable nature?
e. Seek wholesome fun and good companions?
f. Regard your health and the heredity you may give your future children as more important than any enticing venture?

5. Dramatized skits. Write and dramatize skits showing: (a) a boss firing a man who drinks, and explaining why it makes him less efficient; (b) a boss hiring a man, asking him questions about his habits, and explaining why he asks these questions; (c) a reporter interviewing a doctor on the effects of alcohol and tobacco on health and heredity.

6. Reports.[1] (Stress scientific evidence, give authorities. See "How Scientific Are You?" page 555.)

a. Is alcohol a food?
b. Is the use of drugs a physical or moral question or both?
c. Alcohol and tobacco versus athletic ability.
d. Why it is worse for a woman to smoke than for a man.
e. Morphine.

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[1] You may extend this list almost indefinitely, bringing in additional information (see References). Probably the one most valuable source you must not miss is *A Syllabus in Alcohol Education* by Bertha R. Palmer. Write for it to the National W. C. T. U. Publishing House, Evanston, Ill. Price 25¢ per copy, $2.25 per doz.

7. A study of drug advertisements. Compare the statements made in advertisements of liquor, tobacco, and patent medicines with the facts you know about these drugs.

8. Key words. Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each:

drug
poison
narcotic
stimulant
depressant
addict

SUGGESTED REFERENCES[1]

Bogen, Emil, and Hisey, L. W. S., *What About Alcohol?*, Angelus Press, Los Angeles, 1934.

Donnelly, Grant L., *Alcohol and the Habit-forming Drugs*, Alfred Williams, Raleigh, N.C., 1936.

Harkness, K. M., and Fort, L., *Youth Studies Alcohol*, Benjamin H. Sanborn, New York, 1937.

Hatcher, Robert A., *Useful Drugs*,* American Medical Association, Chicago, 1937. (A doctors' handbook.)

La Roe, Arthur, "Marijuana, the Weed of Crime and Madness," *Health Magazine*, October, 1938.

Tunney, Gene, "Nicotine Kockout, or the Slow Count," *The Reader's Digest*, December, 1941.

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[1] Some of the best references for this problem have been given in footnotes, pages 358, 360, 367, and 368. See also, books listed in *General References*, page 551.

* For advanced pupils and teachers.

Unit VIII. *Becoming What You Want to Be*

DO YOU know what it takes to be what *you* want to be? That is a question you should think through seriously – and the sooner the better. Ask yourself how well you will be able to get along without sufficient health and vitality to live up to your ambitions; without mental and emotional poise to keep you steadfastly on your course; and without a strong and likeable personality, and the ability to get along with others.

Such traits have always been assets socially, but now they have become almost economic necessities. Most employers rank them along with training and skill. Many large department stores rate every employee monthly on a score card in which health is the very first item.

No matter what you want to be, this unit should help you in developing those fundamental habits, attitudes, mental skills, and personality traits which you are bound to need in the attainment of your goal. Make your own application of them as you study the unit.

Problem 21. *How Can You Make Thinking Increase Your Vitality?*

What is it that makes him so different from other folks? It is the thoughts that he thinks all to himself. — HAROLD BELL WRIGHT, *Shepherd of the Hills*

STUDY OUTLINE

A. Why it matters what you think
  1. Why does the body die when the brain dies?
  2. What do your thoughts have to do with your emotions?
  3. How do your emotions affect your health and vitality?
  4. What type of evidence indicates that thoughts (and resulting emotions) affect the body?

B. How to attain emotional control
  1. What are "positive" and "negative" attitudes?
  2. How can you test your mental habits?
  3. What general method can you use to overcome negative thought habits?
  4. How can you overcome certain destructive habits such as hurry, worry, and overconscientiousness?

C. Some thoughts that promote vitality and help cure disease
  1. Why is it best to heal the mind as well as the body?
  2. What scientific facts help give you faith in your own body?
  3. How can vitality be increased by the use of: (a) imagination, (b) gratitude, (c) service, (d) success, (e) laughter, (f) literature, (g) religion, (h) getting out of doors, (i) music?

IF ANYONE questions your thoughts, you probably would like to reply, "My thoughts are my own, and it's nobody's business what I think!" Your thoughts, however, influence your actions, and these in turn affect all persons whom you contact. Hence your thoughts are the concern of others. For the purpose of this discussion, however, we will consider only the selfish question of *what your thoughts do to your own body.*

WHY IT MATTERS WHAT YOU THINK

Although the study of the effect of thoughts and emotions on the body is one of the newest branches of science, extensive data have already been collected. In the following pages we can mention only a few of the most outstanding conclusions.

The nature of the brain and its control over the body. Experiments give evidence that the brain cells generate electric currents which, it is believed, are distributed by the nerves continuously to all cells and organs of the body, energizing them and keeping them alive. It seems probable that those currents have a great deal to do with the functioning of the body organs.

Other facts that support this theory are: (1) any part or organ dies when its nerve supply is cut off; (2) organs stimulated by artificial electrical currents respond the same as from natural brain currents; (3) the brain "runs down" electrically like a battery and requires sleep to recharge it. From all this it appears that it *does* matter very much (to your own body) what goes on in your brain.

The brain as the seat of emotions. Of the emotions, it is sufficient to say that they are *expressions of feeling* — anger, fear, joy, love, and sorrow. It has been proved that they arise from the brain only, and not from the heart or glands. You may, for instance, work yourself into a state of real anger purely by imagination. Whether a certain circumstance will make you laugh or cry, become furious or remain calm, depends on *how you think about it.*

How anger and fear affect the body. Have you ever known anyone to display "superhuman" strength in escaping or rescuing others from danger? Such ability is produced by the increased secretion of adrenalin. (Read again the mechanism by which it summons the powers of the large muscles, page 324.)

If emotions such as fear and anger are aroused when the body has no need for great physical energy, they may produce harmful effects. (Remember, the secretion of adrenalin into the blood is an instantaneous reflex action started by fear or anger.)

1. Adrenalin *stops peristaltic action.* Professor Cannon[1] noted

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[1] Walter B. Cannon, *Bodily Changes in Pain, Hunger, Fear, and Rage*, D. Appleton & Co., New York, 1929. (Interesting and easily understood.)

that even slight emotional upsets such as the anxiety of a mother cat for her kittens produced this effect.

2. Adrenalin also *stops the secretion of digestive juices.* Professor Cannon found that a dog, infuriated for 5 minutes by a cat, was then pacified and fed. He was hungry and ate eagerly, but in the next 20 minutes his stomach secreted only a very small amount of gastric juice. In other cases 2 or 3 minutes of emotional stimulation caused the flow of gastric juice to cease for several hours.

3. Adrenalin *raises blood pressure* and *stimulates the heart.*

4. The body's defense mechanism is aided when adrenalin *stimulates the liver to pour sugar into the blood* as added fuel for the muscles. Within a few minutes following excitement the blood sugar rises from 10 to 30 per cent. If the body is able to use this extra fuel, as in great physical effort, no sugar appears in the urine. If the body cannot burn it, however, the kidneys must eliminate it. If this condition becomes permanent, it is known as "diabetes."

Professor Cannon brought about such temporary excess sugar in cats by letting a dog bark at them for half an hour. He and others also found that very few college students showed excess sugar after easy examinations, but that nearly half of them did immediately following hard examinations.

Emotional habits and diseases. When you spend an hour in resentment, worry, or self-pity, you are piling up internal trouble for yourself. Laboratory tests show that a few moments of such emotional excitement may produce so much extra adrenalin, thyroxin, blood sugar, and cell wastes (due to increased metabolism), that your body may require hours to eliminate them. Hence emotional upsets cause actual bodily harm if they are allowed to occur often or to be prolonged. Since destructive emotional habits have such grave effects on nutrition, metabolism, and elimination, as well as on blood pressure, heart action, relaxation, and sleep, they may interfere seriously with the normal functioning of all body organs, particularly the heart, liver, kidneys, nerves, and digestive organs.

Emotions and vitality. Watch yourself and others and see how often a cold follows within a few days after a period of mental confusion. This is explained by Dr. Crile's discovery that destructive emotions waste energy and lower the vitality of all the cells.

138 Team games are fun and are also good developers of a spirit of co-operation and good sportsmanship. Every boy and girl needs this experience.

thus decreasing their resistance to any kind of infection, especially colds. If a person is ill, this effect hinders his recovery.

At first, the decrease of vitality will only make you "unaccountably pepless." This happened to one young woman as a result of four days of worry. A blood count showed that she had destroyed one third of the red corpuscles in her body! She learned her lesson dramatically, righted her mental attitude, and soon rebuilt her red corpuscles without the need of any other remedial measures. Accurate blood, urine, and metabolism tests could show you, too, what price you really pay for lack of emotional control.

Emotional control versus nervousness. Destructive mental states such as anger and worry are among the chief causes of nervousness. Constructive mental habits, on the other hand, can prevent and help cure it. Assuming that there are no physical factors involved, the prevention of nervousness is a matter of education in controlling your own thoughts and emotions. Dr. Sadler expresses the viewpoint of a modern specialist on this point:

"The real time to help these [nervous] people is when they are in the cradle. Parents should early teach these children thoroughgoing self-control, raise them to learn to go about their business independent of their emotional whims or their passing neurotic feeling of fatigue, and

> help them early to learn to make decisions, to settle things, and then to settle it that they are settled.
>
> "We can best prevent nervousness in the adult by training the child to play the game, to take defeat joyfully, to be cheerful in the presence of disappointment; to take correction without sulking; to have his way crossed without indulging in an emotional sprawl. These are the children that need to be raised with a sense of duty to the world and to practice unselfishness in the home, and self-denial with respect to their playmates and companions. Responsibility should be early inculcated and they should not be allowed to brood over fancied slights and to develop undue sensitiveness. They should be made to play, to engage in competitive games and in this way learn how to take defeat and adjust themselves to petty failures." [1]

If you did not learn this self-control and good sportsmanship as a child, do not blame anyone. You are now able to take charge of your own training. Hence, if you *continue* to be a "poor sport," to be overly sensitive, to have temper fits, and to be worried, it will be *your* fault from now on! The remainder of this problem gives practical suggestions on how to gain emotional control. You can also find many helpful books in the library. Some of them are listed on pages 387 and 401.

HOW TO ATTAIN EMOTIONAL CONTROL

The encouraging aspect of all these discoveries is that your feelings and their effects depend entirely upon what goes on in your brain. Since you can learn to think the kind of thoughts you want to, it is possible to control your emotions, yet very few people know how to do this efficiently and satisfactorily.

Taking stock of your emotional habits. In developing emotional control, you must get a clear idea of the essential steps to be taken. Table VI has been prepared to help you analyze yourself and define your objectives. Refer to it often. You may want to copy parts of it for handy reference.

Those traits which appear in the first column are the most common "negative" traits — destroyers of physical energy and health as well as of mental poise and happiness. The third column represents the opposite extremes which are equally destructive to a pleasing personality and happiness. The "happy medium" appears in the center column of the chart, and represents traits that tend definitely to promote physical health. Cultivate them earnestly, for your own sake.

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[1] Wm. S. Sadler, *Essentials of Healthful Living*, The Macmillan Company, New York, 1925, p. 411.

TABLE VI

Mental and Emotional Tendencies

Negative traits destructive to both health and happiness	*Normal positive traits constructive for health and happiness*	*Opposite extreme traits destructive to fine personality and happiness*
1. Fear, superstition	**Caution, trust, courage**	Daredevil spirit
2. Worry	**Faith, confidence**	Carelessness
3. Despair, depression, pessimism	**Hopefulness, cheerfulness**	Day dreaming, blind optimism
4. Anger	**Love, understanding, righteous indignation**	Too submissive, unprovokable
5. Resentment	**Ability to face facts, scientific attitude**[1]	Indifference
6. Self-pity, selfishness	**Gratitude, generosity**	Too complete forgetfulness of self
7. Jealousy	**Love, unselfishness, sense of independence**	Abject devotion
8. Overambition, false egotism	**Ambition, eagerness**	Inertia
9. Self-blame, regret, remorse	**Scientific attitude,**[1] **facing facts squarely**	Self-praise, self-righteousness
10. Hurry	**Calmness, poise, patience**	Sluggishness
11. Discouragement, lack of tenacity, giving up easily	**Tenaciousness, persistence, aggressiveness**	Unreasonableness, stubbornness
12. False sentimentality (gushing)	**Practicality, honesty, cordiality**	Coldness, lack of sympathy
13. Critical (mentally or objectively)	**Friendly understanding, seeing good in others, "live and let live"**	Nonanalytical of situations you might help improve
14. Indecision	**Vitality, decisiveness**	Recklessness
15. Resistance to people and conditions	**"Getting easy with life"**	Being a "door mat"
16. Feeling of inferiority, timidity	**Self-confidence, poise**	Egotistical, domineering
17. Oversensitiveness to others	**Self-confidence**	Blasé

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[1] See "How Scientific Are You?" page 555.

General methods of overcoming negative emotions. The highest level of emotional control is to change the negative feeling into its opposite positive one by controlling the thoughts which produce the energy. Psychologists call this *sublimation* or *transmutation of impulses*. It is accomplished by a mental trick called *thought substitution* that works on the psychological principle that "Two thoughts cannot occupy the same mind at the same time." You cannot possibly be angry with someone and love him at the same time, though your thoughts may alternate rapidly between the two. When angry with him, if you will persistently hold your attention on some of his good qualities, or try sincerely to understand and see his side of the question, your anger will soon vanish. (Remember, you are doing this for your own sake, not his.)

You can practice this method of thought substitution until you reach a stage of poise and serenity under all circumstances. To overcome any destructive trait (listed in first and third columns of Table VI), consistently practice its opposite positive trait (in the center column) every time occasion arises. The positive trait will become habitual, and the old, negative feelings will gradually cease even to appear -- simply keep your attention on the positive trait you want to develop.

Conquering the hurry habit. Hurry defeats its own purpose because contradictory nerve impulses to the muscles result in frustration, undue fatigue, and loss of efficiency. The sense of pressure is one of our most destructive American habits. When you become internally tense with hurry, stop that very moment, calm yourself, then proceed more deliberately. You'll really get there faster! By practice you can learn to move rapidly while maintaining an intense inner calm that nothing can disturb.

Multiple responsibilities. Having many things to attend to at once causes much nervousness. To conquer the excited feeling it produces, write a *daily plan of work* so that, as far as possible, you need think of but one thing at a time. Train yourself to shut out all thoughts of the things you cannot possibly do at the present moment. Also, try to realize that your work is not a matter of life or death, that the world could still go on without you, and that you aren't as important as you think you are.

Overconscientiousness. This is but fear of imperfection. If you are extremely conscientious, conquer your sense of self-importance as well as your desire for praise, and learn to work well without being fussy about it.

"Kicking against the pricks." This is one of the most nonsensible ways whereby people waste nervous energy. As far as possible plan your study and work so as to be able to do the type of thing you wish to do. But if you have to do something else, adjust to the new condition, see the good in it, do your best, look for ways to express yourself through your leisure if not your work, and ever keep faith in your ultimate goal. "If you can't do what you like, learn to like what you have to do" is good science and good sense! (See Fig. 139.)

139 Every job is bound to have some aspects you might not like. Learn to take such tasks "in stride" as these sailors are doing. (Photo by Jakobsen, Los Angeles *Times*)

Single-track thinking and worry. Allowing your work, grudges, or pet worry to possess your mind twenty-four hours a day is bad business, and, in the extreme, leads to nervous disorders, dissociation of personality, and temporary insanity. When one topic governs your thinking so completely that you cannot drop it at will, it is advisable to seek some absorbing activity that will divert your attention into new channels. Reading, movies, radio, or gardening may do this in mild cases; but where a severe nervous disorder is threatened, it may require a complete change such as making new friends, moving to a new locality, or tackling a different job.

The best preventive of such difficulties is many friends and in-

140 You live in an era which increasingly needs young people who can and will unselfishly and open-mindedly co-operate in serious problem solving. (Courtesy of Los Angeles Board of Education)

terests, including a hobby or two, and the realization that *no material thing is as important as your peace of mind.* Learn to hold life, happiness, and personality far above the minor things that may cause you worry. Don't permit yourself to think of unpleasant things except when you can do it in a constructive, hopeful way, seeking to better the situation. When you begin to "think in circles" and to worry, criticize, and blame yourself and others, it is time to drop the subject, and force yourself to think of something else until you are mentally rested and calm.

When your mind is confused, go outdoors and breathe deeply. Learning to feel at home in the universe will help you to keep in their proper relationships the petty things about which you might fret.

Are you a fanatic? One of the greatest needs of people today is a sane attitude regarding religion, organizations, forms of government, and customs. You cannot become a fanatic if you realize that all people are alike in their desire for a better life but different in their way of seeking and expressing it. Tolerance, the attitude toward others of "live and let live" would do away with much useless bickering, and would preserve the balance of countless nervous systems. (See Fig. 140.)

SOME THOUGHTS THAT PROMOTE VITALITY AND HELP CURE DISEASE

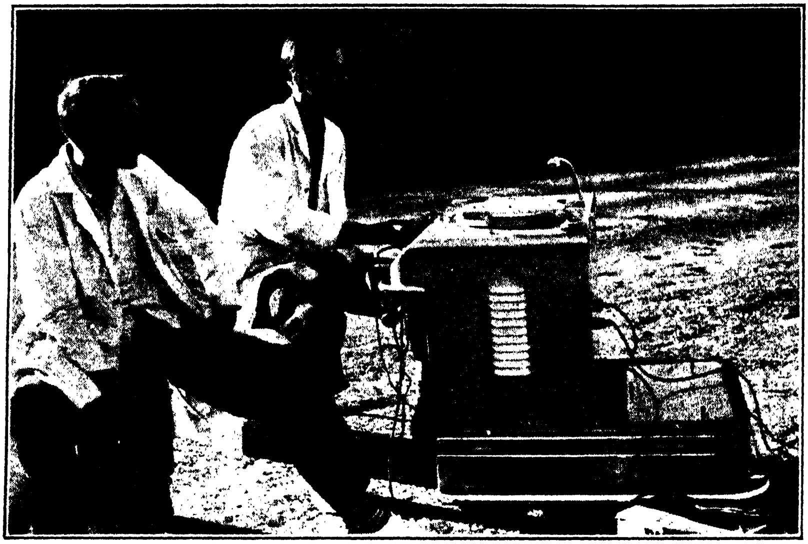
Whether you realize it or not, every thought you have produces an effect on your body for either good or ill. Why not develop the habit of thinking positive or constructive thoughts that aid circulation, relax tense muscles, keep the heart beating normally, stimulate digestion, relieve nervous tension, and raise the vitality of all the cells and organs of the body?

Healing both mind and body. The most scientific way to speed recovery from any disease is through a combination of physical and mental treatments. In this way a permanent cure, also, is more certain. In many illnesses where continued treatment seems necessary, probably only the symptoms are being treated and not the real cause, which may be an emotional one.

Although numberless thousands of cases have been cured through the mind and emotions alone, it is unsafe to assume that all diseases can be cured in this way. In the hands of the ignorant this method may be dangerous, for it may lead to criminal carelessness in spreading disease to others and in inviting death for one's self through refusal to heed the body's danger signals. It is safest to work on all planes — physical, mental, and spiritual. There is nothing incompatible in doing so, for all three work together to help body cells do their work normally.

Trust your own body. You know now that your body has marvelous automatic regulators for all its needs. Some of these are the regulation of heartbeat, breathing, and size of blood vessels according to need; the rushing of white corpuscles to a point of injury; the liberation of sugar by the liver; glandular action; and the secretion of digestive juices when food is taken. These processes all go on best if you don't interfere with them by consciously trying to run them. Even your legs don't work properly if you think about every step! (Try it.) Therefore give your body what you know it needs, don't abuse it, then trust it to do its work properly.

If you are ill, obey the doctor's orders, and then expect the natural healing power of your cells to supplement his treatment. This attitude will help you to relax and let your cells work unhindered.



141 Many a person has been kept sane and poised by a hobby. These boys have long enjoyed experimenting with electricity. Here they are turning their ability into school service by operating a public-address machine at a football game.

Imagination — your pattern for living. Some people always imagine the worst is going to happen; thus they go through the strain of untold troubles that never really materialize. Others imagine they have every disease they hear about, and the creative power of their own imagination readily produces symptoms that seem very real, although no disease is present. Patent-medicine companies do a thriving business by appealing to the weakness of such people.

Use your imagination constructively to keep constantly in mind goals of perfect health and fine workmanship, so that you may work toward them more efficiently. This makes them easier to achieve, for, according to a recognized psychological law, *whatever is held in the mind has creative power and must eventually come forth into form.*

Gratitude — remedy for "blues." Self-pity is among the worst destroyers of body, nerves, and a likeable personality. "If you want to be miserable, think about yourself," says Charles Kingsley. Your best weapon against this subtle poisoner is the habit of being thankful for whatever good comes to you, regardless of how little it may seem.

Service — the energy liberator. To understand the meaning of the proverb, "Strength comes with the doing," all you need to do is to *try* it. Every individual enjoys the feeling of being useful. Everyone must find some way of satisfying this desire. One of the most depressing thoughts a human being can have is that he is contributing nothing that anyone else wants. Some older people decline rapidly when they retire from active service because they are unable to adjust themselves to the fact that they now serve in a different way. Younger people can help to keep them vital by finding ways in which they can assist about the home. To keep yourself mentally healthy, find various ways of serving others.

142 Everyone can enjoy the thrill of being useful. When you really want to serve, you'll find there are many ways of doing it. This girl is serving her school during her spare time.

The success habit. The joy of accomplishment does something to anyone that is noticeable even in his posture. A sense of failure lowers vitality, invites disease, and retards or even prevents recovery. But nobody needs to be a failure, for success can be developed by anyone. Tackle things that challenge you and are within your ability, and then *see them through to completion.* If you perform well any act of service, you are a necessary part of the human scene and are contributing to the welfare of others, whether as a dish washer, a typist, a builder, a musician, or a politician.

Laughter. When your mind and body become tense, there is nothing like wholesome laughter to relax them! A good laugh will send a fagged brain back to work on a serious task refreshed and clear. Learning to laugh at your own mistakes saves you from embarrassment and makes you a "good sport" in the eyes of others.[1]

Literature — for keeping out of ruts. Too few people realize the immense value of inspiring books, poetry, lectures, sermons, and plays in building up a bulwark of positive attitudes. Don't wait until you are ill to make use of them. Most nervous disorders from mental causes could be prevented by the daily habit of getting away from tasks and people for a few quiet moments with some uplifting literature.

Psychologists say that the most important part of your 24-hour day is the last five minutes before going to sleep. Never go to sleep with negative thoughts, for the subconscious mind works all night on them and tends to build them up as habitual thought patterns. Use the last few moments before dropping off to sleep to help build hopeful and strong mental habits. Good reading before retiring will help you to do this.

Religion — the co-ordinator of energy. Many progressive thinkers today hold that true religion rightly understood, more than any other power known to man, develops faith, joy, and good will. At the same time it strengthens one's efforts, releases great physical and mental energy, and gives to life a richer value and meaning. Many physicians recognize the healing value of prayer and a strong religious faith. (See Fig. 145, page 395.)

The out-of-doors — for a fresh viewpoint. When things go wrong, get out in the sunshine. If you can't see hills and fields just when you need their refreshing inspiration, you can at least see the sky! Even a tiny flower may turn the trick and give you a lift. When opportunity permits, take longer trips to mountains, forests, desert, or seashore. They work miracles on jaded nerves.

The invigorating power of music. Music can arouse all the human emotions. Loud, stirring music stimulates the adrenals and has been found experimentally to hinder digestion. Martial music stimulates these glands just enough to increase energy and courage. Under its influence cowardly soldiers have been made brave.

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[1] A delightful and scientific article on this subject is to be found in *Hygeia*, April, 1938.

Understanding this, you may deliberately whistle or sing when you feel afraid or depressed. Force yourself to do it at first, because you won't feel like it; but soon the music itself will produce the feeling. The more you can enter into the spirit of the music either by producing it or keeping time to it, the greater will be its stimulating effect.

Soft, sweet music relaxes the body, aids digestion, and arouses the softer emotions. Thus music may be used to produce the desired effects. It is now used in factories to speed production and prevent fatigue, and in motion-picture production to create appropriate atmosphere. It is used in hospitals as a healing agent. In 1940, more than 1,000 "healing concerts" were held in 40 New York hospitals. Choose your own music to suit your needs at the time.

Conclusion. Since negative mental attitudes are destructive to health and vitality, you owe it to yourself to develop the *habit* of thinking positively. The most efficient method is to concentrate on developing positive attitudes. Whenever a destructive negative thought arises, substitute the opposite positive one. This will strengthen your positive thought-habits and gradually eliminate the negative ones. You may deliberately build up certain attitudes that promote health. (See Table VI, page 377.)

ACTIVITIES

1. **Self-check on your study of this problem.** See now if you can answer all the questions in the study outline of this problem. Discuss them in class.
2. **A demonstration of the effect of thought on the body.** Tie a heavy finger ring or weight on the end of a string and hold the other end in your hand. Hold your hand still, shut your eyes, and say and think slowly and rhythmically, "left to right, left to right," or "forward and backward." Don't *try* to make anything happen. Observe results after a minute, when you (1) just think the words, (2) whisper them, (3) say them in an ordinary tone, (4) say them emphatically and loudly. What can you conclude from this experiment? Does a thought affect your body more or less if you *say* it aloud?
3. **A self-check on your own mental and emotional habits.** Use Table VI. Rule a separate page for rating yourself as shown here. Since the two outside columns are negative traits, rate yourself from

−1 to −3 on them, −3 being the lowest rating. Since the traits in the center column are positive, rate yourself +1 to +3 on them, +3 being the highest. You cannot have a rating in all three columns for the same item. Why? Rate yourself according to the way you *usually* think and react.

	Negative traits	*Positive traits*	*Negative traits*
1.	— 2		
2.	— 1		
3.		+ 2	
4.		+ 3	
5.		+ 1	
6.			− 3

Choose not more than two traits in which you marked yourself −3 and which you would like to overcome. Plan a definite program for developing their opposite positive traits, make a score chart (page 12) and check yourself on it each day for at least two weeks. (Read again, "How Scientific Are You?" parts B and C, page 555.)

It will be interesting to copy this table and rate yourself on it again in 6 months, and still again in 2 years.

4. Self-development while you sleep. Experiment for two weeks or more on building up positive attitudes while you sleep. Each night go to sleep repeating ideas you wish to emphasize or develop, such as "poise," "courage," etc. (See page 393.) Keep an accurate but brief record of what you read, say, or think each night, and your attitude upon awaking. Record any other observations you think have a direct bearing upon the experiment. After two weeks (not before — why?), what can you conclude from this experiment?

5. Key words. Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each:

brain as body energizer
emotions
"negative" thoughts
"positive" thoughts
thought substitution

Your Health Habits

Check yourself on the following habits. *Note.* You checked most of your health habits for this problem when you did Activity 3, above. In addition to those, do you —

a. Try sincerely to control your emotions?

b. Try to substitute positive thinking each time you start negatively? (Use Table VI.)

SUGGESTED REFERENCES[1]

Carrel, Alexis, *Man the Unknown*,* Blue Ribbon Books, Garden City, N. Y., 1938. (Selected parts.)

Chappell, M. N., *In the Name of Common Sense — Worry and Its Control*, The Macmillan Company, New York, 1938.

Gavian, R. W., Gray, A. A., and Groves, E. R., *Our Changing Social Order*, D. C. Heath, New York, 1934, pp. 199–219.

Josselyn, Daniel W., *Why Be Tired?* Longmans, Green & Company, New York, 1936.

La Rue, Daniel, *Mental Hygiene*, The Macmillan Company, New York, 1932.

Marston, W. M., "You Might as Well Enjoy It; boredom may be the raw material of pleasure," *Reader's Digest*, September 1938.

Meredith, F. L., *The Health of Youth*, P. Blakiston's Son, Philadelphia, 1928, pp. 467–518.

Sadler, Wm. S., *Worry and Nervousness or the Science of Self-mastery*, Health Press, Chicago, 1930.

Walsh, James J., *Laughter and Health*, D. Appleton & Co., New York, 1928.

Walsh, Wm. S., *The Mastery of Fear*, E. P. Dutton, New York, 1933.

—— *Peace of Mind and Body*, E. P. Dutton, New York, 1933.

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[1] See also, references given in footnotes, pages 373, 376, and 384. Most of the suggested references for Problem 22, and some of those for Problem 16 contain good material for this problem.

* For advanced pupils and teachers.

Problem 22. *How Can You Develop Your Personality?*

I am the master of my fate;
I am the captain of my soul.
— WILLIAM ERNEST HENLEY, *Invictus*

STUDY OUTLINE

A. The bases of personality
   1. How much does your personality depend upon heredity?
   2. How do you acquire complexes? Are they good or bad for you?

B. Studying your own personality
   1. How can you test your beliefs and motives?
   2. How can you tell what kind of person you were born to be?
   3. Why do so many adolescents enjoy doing "wild" things?
   4. Why is faith in the universe important?

C. Learning to get along with others
   1. Why do some people of normal intelligence have an empty look on their faces?
   2. How can you learn to get along with your parents, teachers, and employers?
   3. What can you do to improve your relations with younger brothers and sisters, and with classmates and friends?

HAPPINESS is that intangible something — being truly alive. Think of happiness as a threefold adjustment to *yourself*, to *others*, and to the *universe*. Your *personality* is the result of the way in which you make these adjustments to life. You manifest them outwardly through your skill in work and play, your speech and other means of self-expression, your personal appearance, especially your posture, your mannerisms, and your adjustments and reactions to people and to situations. But fundamental to them all are just two things — physical vitality and wholesome mental attitudes. Without these, all exterior polishing is useless, for the world soon sees through the exterior.

THE BASES OF PERSONALITY

In your adjustment to yourself, to others, and to the universe you have to start with what you had at birth, namely, your inherited tendencies, plus the personality you have acquired thus far. You might begin by becoming better acquainted with your present self.

Heredity and personality. You do not inherit a personality — you develop one. You do inherit a certain type of nerve, bone, and muscle structure. This enables you to do best certain types of work, such as that requiring fast co-ordination, deliberate thought and action, quick decisions, deep concentration, or accuracy. The mechanism that makes possible musical, mathematical, artistic, and dramatic ability is inherited. Thus, you were born with certain *tools* and *materials* with which to build your personality. You yourself must determine how you will build.

Emotional tendencies are more important to personality than either physical or mental traits. Emotions have an inherited foundation, probably based somewhat on the type of endocrine system inherited. Regardless of gland function, however, all normal people can learn to control better their emotional responses.

Personality types. Side-show "character readers" and astrologers promise to tell you your inherited type according to your appearance or handwriting or the stars you were born under. All such classifications of people are highly unscientific and inaccurate. For example, in star forecasting, two *nonidentical* twins would have the same "reading," yet an exact study of heredity proves that they have only one chance in 500,000 of inheriting the same combination of traits so as to be exactly alike!

Environment and personality. Inherited tendencies are not rigidly fixed; they are merely *tendencies* to respond in certain ways. Environment must furnish the materials necessary for proper development. Sometimes environment may warp and change a person because of lack of opportunity for favorable growth. Deficient diet or diseased glands may change the actual shape and size of a child's bones and muscles and alter his facial expression. The use he makes of his mind, and even the way he expresses himself in conversation, depend upon the way his brain is developed by

143 Did you ever analyze the personality traits of the people you choose as school leaders? Do you realize that they have been *developing* these traits constantly for years? You, too, can develop worth-while traits.

contact with others in the home, playground, and school. You must learn to control your own development from within, and not let poor conditions in your environment dominate you.

The strain of competition and the machine age, to say nothing of chaotic war conditions, are throwing more and more personalities off balance. The result is such an appalling number of nervous wrecks that intense interest[1] is being manifested in the development of well-balanced, integrated personalities. Don't aim merely for a personality that "puts you over" — strive for a strong one that "keeps you up."

How complexes are formed. By the time many children are three years of age they have come to fear fire, the dark, certain people, some animals, and many other things. Some of these fears are wholesome for the child's safety, such as a fear of fire and passing automobiles; but most childhood fears are cruel, and if not overcome immediately they may become so firmly fixed that they may never be completely erased. For instance, many an adult finds it almost impossible to learn to swim because of an unaccountable fear of the water. This unnatural fear probably developed in babyhood when he may have been allowed to slip in his bathtub, or to fall into some body of water, or was teasingly "ducked." An idea of this kind which arouses a certain emotion is called a *complex*. The idea and the emotion may become connected in the association centers of the brain through one strongly felt experience or be built up gradually through many experiences of similar nature.

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[1] You will find in public, as well as in school libraries, many excellent books and magazine articles on mental health and personality. Some of these may prove to be the most worth-while bit of reading you have ever attempted.

When anyone develops an unnatural response of this nature through experience, his response is said to be *conditioned*. A complex, then, is a conditioned response which involves deep emotion. Your past experiences have conditioned you so that you either laugh or seek sympathy for petty hurts, you either like or dislike certain kinds of people, music, colors, and surroundings, and you have distinct feelings aroused by the ideas of mother, home, country, political party, club, or church. Some of these feelings are healthful, others harmful. By understanding them all, you may overcome your harmful ones.

The vitality behind personality. A very significant foundation stone of personality is vital energy expressing itself as enthusiasm and ambition (see frontispiece). Most great personalities have been characterized by abundant vitality. There was an unusual vigor about such people as George Washington, Benjamin Franklin, Florence Nightingale, Jeanne D'Arc, and Theodore Roosevelt. Enthusiasm need not be gushing. The quiet strength of an Abraham Lincoln is more conducive to confidence and lasting respect. Such energy is best secured from healthy, harmonious functioning of the bodily organs, resulting from conformity to sound health practices. Great vitality can make a personality so strong as to overshadow even physical deformities.

STUDYING YOUR OWN PERSONALITY

To become acquainted with yourself, start by examining your habitual reactions and complexes. You may discover nervous habits acquired from those about you, although in reality you have calm nerves and good poise. You may discover false ambitions for which you have no real liking or aptitude, which you have picked up from imitating others.

Thinking for yourself. You may have to admit that you harbor certain prejudices not based on scientific facts or good sense. Race and class hatreds are of this type, as are antisocial complexes against law, religion, government, or restraint in general. Some people have the habit of opposing every suggestion, while others automatically say "yes" to anything.

People who stand out as strong personalities are constantly testing their habits, ideas, and beliefs in the light of all the facts they can gather. They consciously believe and act as they do because they have definitely chosen what they think is best. In buying clothes, they select what fits their own type and coloring instead of trying merely to be in style or to duplicate a gown or suit that some movie star has worn. They develop their own voice characteristics and speak naturally instead of affecting the mannerisms of others; and they vote a certain way because they believe it is the best for society, and not just to comply with the dictates of a party leader. To get somewhere, think for yourself; to get nowhere, follow the crowd.

Studying your real motives. Complexes are dangerous inasmuch as they control feelings and acts without your being aware of it. The person with an inferiority complex becomes easily hurt. A normal, clear thinking individual cannot be offended; if a criticism is justified, he admits it honestly and makes it a stepping-stone to self-improvement; if it is unsound, he simply ignores it and forgets it. The person with a complex against a certain race spurns all members of that race, whereas the person without such a complex accepts all individuals of all races for what they prove themselves to be. For most people the conception of "home" is a noble one; but if it makes a person snobbish toward others with lowlier homes, or if it keeps him so sentimentally tied that he is unhappy elsewhere, it is undoubtedly detrimental to his personality. Examine your complexes, and replace destructive emotional habits with others that make for stability and happiness.

Fooling yourself — rationalization. In self-examination, be careful to avoid the common mental trick called "rationalizing." This consists of acting the way you *feel* and then figuring out a logical-sounding reason to excuse yourself. Many people rationalize (excuse) their moods, outbursts of temper, fussiness, and other shortcomings on the basis of illness, "nerves," or irritating circumstances, whereas if they were honest with themselves, they would know that these are but habits which they have never taken the trouble to conquer. Learn to be absolutely honest and willing to look at yourself as if you were studying someone else.

Key traits of personality. To discover the basic elements necessary for your self-expression, observe (1) the things you can do best, (2) the traits you admire in others, and (3) the things that have made you feel, at times, that "It's good to be alive; all's well with me and the world!" A careful study of such occasions will probably show that in each instance one of the following elements predominated in your feelings: (1) *poise* — deep inner calmness; (2) *power* — success, mastery over tasks and circumstances; (3) *plenty* — a sense of an abundance of everything needed; (4) *love* — goodwill toward everybody and everything; (5) *life* — abounding health; (6) *faith* — a belief in yourself and the goodness of the universe; (7) *wisdom* — the ability to guide your actions well; (8) *service* — something worth while accomplished for others; (9) *joy* — a deep, inner feeling of contentment and happiness; (10) *gratitude* — true thankfulness.

Though many or all of these emotions may be necessary for the greatest happiness, the one that predominates when things go right and is missing when things go wrong for *you* may be called the "key trait" to your personality. It is usually not the feeling that comes easiest to you; in fact, it is often the most difficult for you to maintain. There may be also two or more secondary traits especially necessary to your well-being. It may take time to determine the traits you need most to develop, but as soon as you are convinced of even one trait, try earnestly to develop it *within your own mind* as well as to arrange outer circumstances to be conducive to it.

Extroverts and introverts. Another helpful method of self-analysis has been given to us by the famous psychiatrist, Jung, who classifies people as "extroverts" or "introverts." Extroverts are

144 Little do you realize the value your present experiences may prove to have. These boys are making good use of their opportunities in the school print shop. Are *you* getting the most you can out of everything you do?

focussed on things outside of themselves. Their emotions are expressed in muscular activity and in association with other people. They are good "mixers"; they tend to be "happy go lucky." Introverts are focussed on things largely within themselves; usually they work or play alone rather than with others; and they have keen imaginations. They are thinkers, artists, and musicians.[1]

Most people possess some traits of each type — extrovert and introvert. It is believed that the finest, most stable personalities are those in whom the two types of traits are about equally balanced. For instance, *doing* must be hooked up with *thinking* and vice versa; and everyone should be able to work independently as well as to co-operate harmoniously when necessary. If you are extreme in either direction, try to develop sufficient traits of the opposite type to keep sane and balanced.

Special problems of adolescence. Adolescence is the period from

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[1] Professor Laird of Colgate University has selected 50 traits as indicators of personality. From these he devised a rating scale which may interest you. See Donald A. Laird, *Psychology of Selecting Men*, McGraw-Hill Book Co., Inc., New York, 1927, p. 305.

145 No one can give you poise. It must come from within. Find some time even in days crowded with activity to think — to take stock of values. Then you will be able to benefit from all experiences. (Courtesy of Los Angeles Board of Education)

about 12 to 20 years of age, although in some it starts sooner and in many it lasts longer. During this period boys and girls find it most difficult to understand themselves because their glands are changing and they seem to have conflicting desires and moods. They are often very emotional, sentimental, and excitable and are convinced that no one understands or fully appreciates them. During this natural growing-up process, they are stirred by new urges and ideas which incline them to think they know more about how to run a life than anyone who ever lived. These youthful visions and ambitions should be capitalized upon for practical constructive accomplishment. You may have your head in the clouds, but you must keep your feet on the ground. Habitual day dreaming, not connected with daily life at least by a thread of possible fulfillment, is one great cause of neurotic conditions during adolescence.

Unconsciously, young people are ruled largely by the desire to seem grown up. In a mistaken idea of what "grown up" really means, some begin to smoke, drink, spend money extravagantly, stay out late at night, or even commit crimes. Some of these boys and girls will never really grow up, while others may mature after a hectic career. Those of courage and understanding, however, enjoy the process of growing up and the independence they see ahead of them. The present becomes a direct step in making their dreams come true at some future time. If you are to grow up normally, keep happy and busy with today's work, play, and study. Try to realize that today is a part of your preparation for the adult

146 Whether or not your audience sees you, your voice portrays your personality. Learning to speak well and at ease is a valuable asset to anyone regardless of his vocation.

responsibilities you are so eager to tackle, such as earning a living, cooperating with others in social and political life, falling in love, and establishing a home.

Adjusting yourself to life and the universe. One rapidly increasing cause of neuroses is a breakdown of faith in the goodness of the universe and its Creator and in the eternal values of life. During the growing process many individuals become confused. Finding that their former ideas were too small to take in some newly discovered truths, they have assumed that they had been wrong in all respects and hence have discarded even those which were sound. It is a safe policy to hold fast to a good idea until you get a better one. Readjust your ideas slowly.

Developing pleasing speech. This is such an important part of personality that it warrants special attention. Your vocal organs (see page 178) work best when you are in good posture, are relaxed in your shoulders and neck, and are breathing fully, from the diaphragm. (Can you see why?) A calm mental attitude also is extremely important. After making sure that these conditions are fulfilled, practice daily using the following principles: (1) For good *quality* of voice, practice vowel sounds while keeping the throat and other air passages as open and relaxed as possible. (2) For a *vitally strong* voice, practice counting, slowly and firmly, putting energy behind each count. (3) For *clear* speech, make your consonants crisp and don't be lazy about the use of your tongue and lips. (4) For pleasing *pitch*, keep your voice reasonably low. You may practice all of these suggestions at once by saying slowly and with emphasis such words as *Tom — night — cow — leave.* Breathe deeply and listen for the open vowels and the clear-cut consonants.

LEARNING TO GET ALONG WITH OTHERS

By far the most important part of your environment is the other human beings in it. Hence, your adjustments to them are the chief element in your well-being and happiness. To be well balanced and happy, you must learn to adjust yourself to your superiors, your inferiors, and your equals.

Associating with others. Every contact with others means an opportunity for improved understanding of life and human nature, shared pleasure, and the giving of service. Every experience makes some impression and many a passing word from a stranger has left an indelible imprint.

Welcome all contacts that do not weaken you, but choose as your close friends only those who bring out your best reactions. Young people, especially, cannot afford poor companions.

Interest in others. The key to becoming a good conversationalist is to be sincerely interested in other people. If you are nervous before others, you are probably thinking of yourself. Self-consciousness vanishes as soon as you truly concentrate your attention on your companions, whether one person or a large group. Interest in others also makes you a good listener, which is equally important for good conversation.

The mental habit of thoughtfulness for others is also an excellent preventive of queer twists of personality and even of certain types of insanity. Dr. Alfred Adler, the eminent Viennese psychiatrist, says that you can develop your human capacities *only* through interest in your fellow beings. He says that people who seek only their own interests don't see things the way normal people do, and are unable to connect their ideas with others. Hence they have a "hangdog" or vacant look on their faces. Such expressions are characteristic of criminals and the insane. Adler concludes, "The highest degree of isolation is represented by insanity. Even insanity is not incurable if the interest in others can be aroused. . . . We must win the patient back to cooperation."[1]

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[1] Alfred Adler, *What Life Should Mean to You*, Little, Brown & Co., Boston, 1931, pp. 254–5. This book is well worth while.

147 Sincere interest in others puts you at ease among them on any occasion. Practice in social etiquette helps you to master the details of behavior so that you may enjoy the fellowship of those about you.

Getting along with your superiors. In certain circumstances everyone must be able to take orders with an "Aye, aye, sir!" attitude. Anyone who has experienced a fire, earthquake, flood, or war realizes the value of this ability to obey instantly. And aside from physical emergencies, business efficiency often requires the giving of orders without explanation. Without being an unthinking robot, you can learn to execute orders willingly and promptly, bringing all your intelligence to bear on the best possible discharge of your duties.

As to getting along with your parents, remember that most parents make some rules which they do not explain, but which their greater experience has made reasonable. Learn to talk things over, frankly and unemotionally, with them. Also exercise great patience with them and yourself while you are growing up. Your opportunity for modern education places upon you the responsibility for trying to understand both yourself and your parents rather than expecting them always to do the understanding.

Learning to be independent in thinking, making judgments, and controlling your own actions is a gradual process. Every normal young person should start practicing these at least by the age of 14. Start by assuming responsibility for the care and arrangement of your own room, or your clothes, or some portion of the house or garden; or for planning, preparing, and serving certain meals; or entertaining your friends; or for budgeting, saving, and spending small amounts of money you may earn or receive as an allowance; or for budgeting and making the best use of your own time.

By the age of 20, you should have developed and demonstrated such powers of self-management, self-control, and good judgment that you can be trusted under all circumstances. Then you need no longer lean on your parents as a child to be guarded and worried over, though they should always remain your best friends and advisers.

Getting along with those of lower rank. To be a leader is not nearly so important as to be a *good* leader. The secret of being a respected boss is the ability to put yourself in the place of those you supervise and really treat them as you would like to be treated. Never ask another to do anything you would not be willing to do yourself. A good leader takes the attitude that all are working together on a task where differences in position are merely an arrangement for better co-ordination of effort. Hence the boss becomes one of the gang or the captain one of the team.

Getting along with younger brothers and sisters hinges largely upon respecting their rights and ideas. Each individual has a right to a certain amount of privacy and should have some place to call strictly his own — if not a room, at least a drawer or cupboard. Rivalry among brothers and sisters, if friendly and sportsmanlike, is fine; but if selfish and jealous, it is a great cause of neuroses. Determine to be your best self, regardless of everyone else in the world, and to let them be themselves.

Getting along with equals. This is the most difficult adjustment to make. School life, especially on the athletic field, in science laboratories, and in club activities, affords you great opportunity for developing the ability to get along well with your equals.

You are preparing yourself for success in all these relationships when you learn to co-operate with class and teammates and brothers and sisters. True co-operation requires that you do your share of the work at hand and permit others the same privilege, even though they may not do it as well nor as quickly as you could.

Conclusion. Since you inherit the basis for physical, mental, and emotional reactions, it is useless and foolish to try to be like anyone else. "To thine own self be true." Develop your personality from within and make it so strong that adverse environmental conditions cannot disturb your peace of mind. The person who knows what he thinks and why, and is sure of himself, is respected by others.

Study your own natural abilities and tendencies, strengthen your good characteristics by using them, and replace your undesirable ones with opposite good ones. Learn to get along with others by developing (1) a sincere interest in them, and (2) the habit of imagining yourself in their place.

ACTIVITIES

1. Self-check on your study of this problem. See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. Self-analysis of your complexes. List your own most dominating beliefs and prejudices (complexes). Have you a reason for each? If not, should you necessarily discard it? If you are certain that it is unsound scientifically, what can you do about it? On your list mark with a (+) those that you think you should keep; with a (−) those you are sure you should overcome; and with a (?) those you believe are sound, though you do not now know why. Time and greater understanding of life will take care of those marked (?). (Read again, "How Scientific Are You?" page 555.) Start overcoming those marked (−).

3. A study of your own personality. List the good characteristics you think you were born to possess. If some of these are not evident or are weak at present, choose one or two and start developing them. Make and use a score chart (see pages 12–15).

4. Writing an editorial. Let a committee write the script for and present a press interview of an employment-agency manager. Let the reporter ask for information concerning the value of certain personality traits in jobs of various sorts, and for a few experiences in placing people. Let each member of the class write an editorial concerning the interview. An editorial is an expression of your own opinions about the interview. It should bring out the importance of personality in job placement; the responsibility for proper personality development and how it can be accomplished; what society can do about people whose personalities are such that they fail in any job, etc.

5. A personal problem of adjustment. If your personality clashes with some other (as a parent, brother, sister, or friend) try to analyze the situation as if you were some disinterested judge. What would you advise yourself to do? Start applying the ideas in this unit. Keep a record of what you do and of the results.

6. Reports and book reviews. The references for this chapter are particularly good for reports or reviews. Read and report on at least one of them.

7. Key words. Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each:

personality
inherited tendency
complex
rationalization
"key traits" to personality
extrovert
introvert
"grown-up" or mature
co-operation versus insanity

Your Health Habits

Your health habits are the most important item for this problem. Yet you need no check list — you have made your own if you were conscientious about Activities 2, 3, and 5.

SUGGESTED REFERENCES[1]

Bennett, M. E., *Building Your Life*, Whittlesey House, New York, 1935.
Bennett, M. E., and Hand, H. C., *Designs for Personality*, McGraw-Hill Book Company, New York, 1938.
Bisch, Louis E., *Be Glad You're Neurotic*,* Whittlesey House, New York, 1936.
Bond, F. Fraser, *Give Yourself Background*, Whittlesey House, New York, 1937. (Excellent.)
Burnham, Wm. H., *The Wholesome Personality*, D. Appleton & Co., New York, 1932.
Dodd, E. E., *Fiber and Finish, Studies for the Developing of Personality*, Ginn & Co., Boston, 1925.
Fosdick, H. E., "Building a Personality," *Reader's Digest*, May, 1937.
Gibson, J. E., *On Being a Girl*, The Macmillan Company, New York, 1936.
Grabbe, Paul, *We Call It Human Nature*, Harper and Brothers, New York, 1939.
Hambidge, Gove, *Time to Live, Adventures in the Use of Leisure*, Whittlesey House, New York, 1933.
Hunter, L. P., *The Girl Today the Woman Tomorrow*, Allyn and Bacon, Boston, 1932.
Jackson, J. A., *Guiding Your Life*, D. Appleton-Century Co., New York, 1937.

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[1] See also references mentioned in footnotes pages 394 and 397 and the *Suggested References* for Problem 21, page 387.

* For advanced pupils and teachers.

McLean, Donald, *Knowing Yourself and Others*, Henry Holt & Co., New York, 1938.

Sadler, Wm. S., *The Quest for Happiness*, Thomas S. Rockwell, Chicago, 1930.

Taylor, K. W., *Do Adolescents Need Parents*, D. Appleton-Century Co., New York, 1938.

Walsh, Wm. S., *Cultivating Personality*, E. P. Dutton, New York, 1930.

Wright, Milton, *Managing Yourself*, Whittlesey House, New York, 1938.

Unit IX. *Preventing Disease and Caring for Injuries*

THE love of life is inborn in all. We are thrilled by those dramatic episodes which deal with man's struggle to prevent disease and prolong life. The stories of these victories form some of our most fascinating reading. Many have been relived by the movies in pictures of Louis Pasteur, Marie Curie, and many others. Such pictures relate true stories of achievements which have freed us from many of the horrors that threatened man even as recently as a century ago — horrors such as the "Black Plague" which often wiped out two thirds of the inhabitants of a community; and smallpox which killed 60,000,000 people in Europe in the eighteenth century and crippled or disfigured for life one fourth of the remaining population.

Statistics show that knowledge of methods of control of diseases and care of injuries has increased the average length of life in the United States from 40 years in the eighteenth century to 62 years in 1938. There is no reason why further knowledge should not add many more years to the life expectancy of all of us. How this may be possible will become more and more apparent as you study this unit.

Scientific knowledge can actually save lives, however, only when individuals and groups of individuals become familiar with its facts and apply them. You then are faced with the challenge to become informed concerning the prevention of common diseases and to act accordingly. Also, since accidents are so common, it has become practically a duty to learn the fundamentals of first aid which are included in this unit. In wartimes such study is imperative.

Problem 23. *How Can You Be Protected Against Diseases?*

> Sickness comes on horseback, but goes away on foot.
>
> — W. C. HAZLITT

STUDY OUTLINE

A. What microbes are and what they do
   1. How do bacteria move, eat, excrete wastes, and reproduce?
   2. How can a bacteriologist identify bacteria in test material?
   3. What are some common diseases caused by each: bacteria, yeasts, molds, protozoa, and viruses?

B. The prevention of germ diseases
   1. What is an infection?
   2. How do microbes leave the body of a diseased person?
   3. How may microbes be carried to, and enter, the body of another person?
   4. What is a disease "carrier"?
   5. What precautions do civilized countries usually take to prevent the spread of disease?

C. Methods of helping the body to resist germs
   1. Why don't more germs gain a foothold in the body?
   2. Does it matter where certain germs enter the body?
   3. How might you lower and increase your general resistance?
   4. What can anyone do to help a patient win his battle against disease germs?
   5. Why are people immune after having had certain diseases?
   6. Can a person become immune to all diseases? Why?
   7. Vaccines and antitoxins — how does each give immunity and for what diseases is it used?

D. Preventing certain specific diseases
   1. How can you prevent respiratory diseases such as colds, influenza, pneumonia, and tuberculosis?
   2. How may you guard against cancer?
   3. What can be done for an allergic person?

E. Community problems in disease prevention
   1. How is your drinking water made and kept pure?
   2. How can you be assured of pure milk and milk products?

3. How are other foods protected against contamination?
4. Are wastes disposed of properly in your community?
5. What should your community do to control the spread of infectious diseases? Is this actually done adequately?
6. What public-health organizations do you have? How do they operate?
7. Do present laws protect your health sufficiently? If not, what can be done about it?
8. What do *you* do to help protect the health of others?

Note. The last three items (6 to 8) will have to be answered by your own activities and thought.

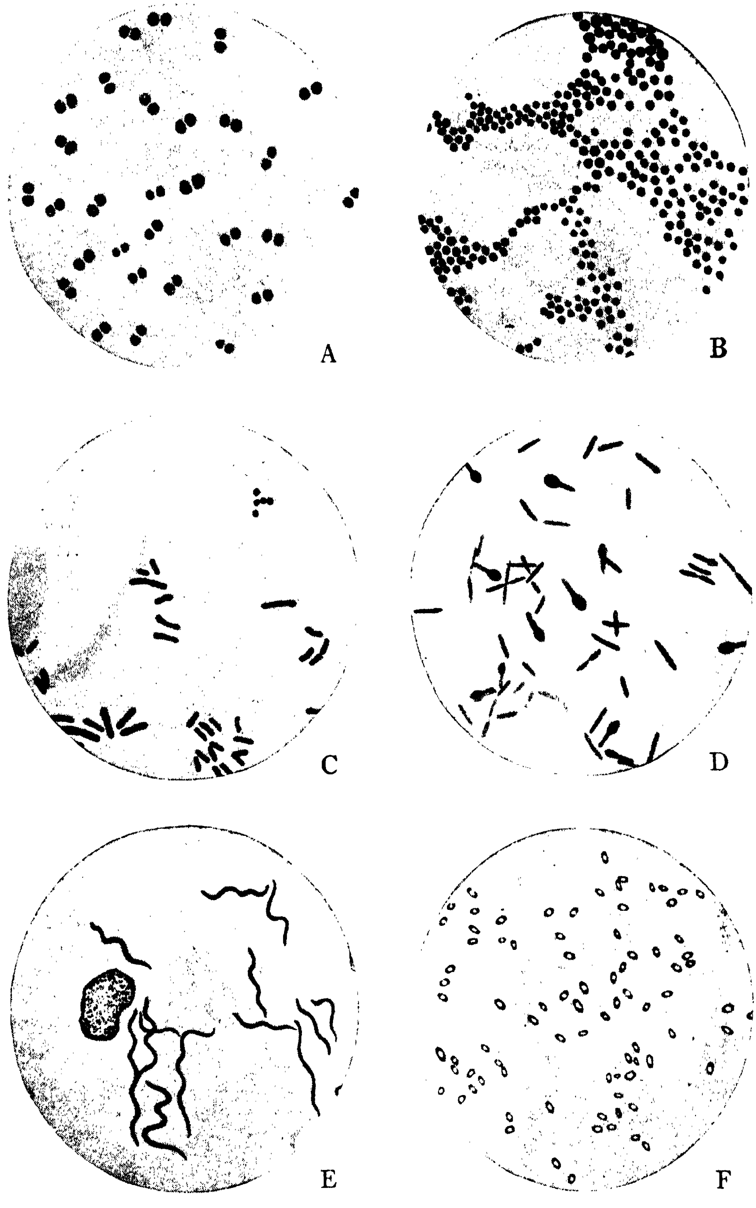
PASTEUR proved, in 1864, that germs can cause disease. Since then the germ theory has become so popular that you are apt to think all diseases are caused by germs. This is not the case, for diseases like indigestion, nervousness, and many liver, kidney, and heart disorders, have no germs in connection with them. These are called *functional diseases.* They often result from unhygienic living or thinking. *Deficiency diseases* result from inadequate diets. Neither functional nor deficiency diseases can be communicated from one person to another.

The *germ diseases*, like pneumonia, tuberculosis, typhoid fever, and diphtheria, are those which have been proved to be due to tiny living organisms. Each is caused by a specific germ and is spread only by passing the germs from one person to another. To protect yourself and others from these *communicable diseases* you need to know something about the life habits of germs.

WHAT MICROBES ARE AND WHAT THEY DO

All forms of life which are, and remain, too small to be seen without a microscope are called *microorganisms* or *microbes.* There are innumerable kinds of such organisms, which may be classified as follows: (1) *bacteria* — simplest form of one-celled plants; (2) minute *fungi* (fŭn′jī) — *yeasts* and *molds*, microscopic plants more complex than bacteria; (3) *protozoa* (prō′tô-zō′à) — one-celled animals; and (4) *filterable viruses* (vī′rŭs-ĕz) — substances of unknown nature because they are too small to be seen with the most powerful microscope; they will pass through the finest filters.

Most of each class of organisms are harmless or even useful to



148 Some disease-producing bacteria. *A. Meningococcus* (produces meningitis). *B. Staphylococcus* (pus-forming). *C.* Tubercle bacillus (causes tuberculosis). *D.* Tetanus bacillus (causes lockjaw). *E. Spirochaeta obermeieri* (causes recurrent fever). *F.* Plague bacillus. Note the characteristic shape of the cocci (*A* and *B*), the bacilli (*C*, *D*, and *F*) and the spirilla (*E*). (Courtesy of Dr. R. V. Stone, Los Angeles County Health Department)

man, but a few are harmful to human cells and thus cause disease. All disease-producing microbes are called *germs.*

What bacteria are. Bacteria are tiny plants without chlorophyl, which feed upon other plants or animals. Enormous numbers of them, mostly harmless, exist all about you, on particles of dust in the air, in water, and even in your mouth and intestinal tract. Each kind lives only where it can get the kind of food it needs. For example, tuberculosis germs can live only in animal tissues or in animal secretions and milk. They will die in pure water.

How bacteria multiply. Mature bacteria multiply by splitting in two much as an ameba does (Fig. 7). Under favorable conditions, many species mature and divide in a half hour or less. When conditions become too cold, dry, or otherwise unfavorable, a few species of *bacilli* (bȧ-sĭl′ī -- one type of bacteria) change into *spores.* These have a dense outer wall that protects them until the environment again becomes favorable, then each spore wall breaks open and the organism returns to its original form. *Sterilization,* the process of destroying living organisms, must be drastic enough to kill spores.

How bacteria are seen and recognized. It is estimated that 400,000,000 bacteria of a certain species would fill a space the size of a grain of sugar. Though magnified a thousand times, bacteria are too small to be studied easily. Laboratory technicians, however, learn to recognize the particular disease-producing bacteria in a general way first according to their shape, as: (1) *cocci* (kŏk′sī), which are ball-shaped; (2) *bacilli,* which are rod-shaped; and (3) *spirilla* (spī-rĭl′ȧ), which are spiral-shaped (Fig. 148).

More specifically, some bacteria are recognized by: an envelope or *capsule* which surrounds them; some by hairlike projections called *flagella* (flă-jĕl′ȧ), which propel them through liquids; others by the stain which will make them visible under the microscope.

How bacteria take in food and excrete wastes. Bacteria digest their food outside their bodies. They secrete enzymes which dissolve solid food in the water surrounding them. Then, by osmosis, food substances as well as oxygen pass through their cell wall, and carbon dioxide and other wastes are excreted. Some excretions from certain bacteria are poisonous to human cells. Hence such excretions are called *toxins.* Disease-producing bacteria bring about their harmful effects merely by the production of toxins. Sometimes these are excreted, while in some cases they are not released from the body of the germ until it dies and disintegrates. Some common disease-producing bacteria are shown in Fig. 148.

What decay is. All decay is merely chemical decomposition resulting from bacterial action. Hence anything free from bacteria will never decay. Some of the products formed when proteins are partially decayed (putrefied) are called *ptomaines.* The idea that they cause so-called "ptomaine poisoning" is incorrect. Poisoning from food is due to certain species of bacteria and their excretions, and it should be spoken of as *bacterial food poisoning.*

The decomposition of sugars, starch, and other carbohydrates is called *fermentation.* When carbohydrates ferment, various organic acids, and sometimes gases, are formed. Certain bacteria produce *lactic acid* and cause milk to sour. Bacteria which cause fermentation are also employed in the preparation of hides for tanning, in the manufacture of linen, in the preparation of manures for use as fertilizers, and in the making of alcoholic beverages.

Prevent decay and disease by controlling bacterial growth. By controlling the living conditions of bacteria their growth can be speeded up or slowed down, or they can be destroyed completely. Methods of preserving foods or disinfecting articles involve creating an unsatisfactory environment for bacteria as follows:

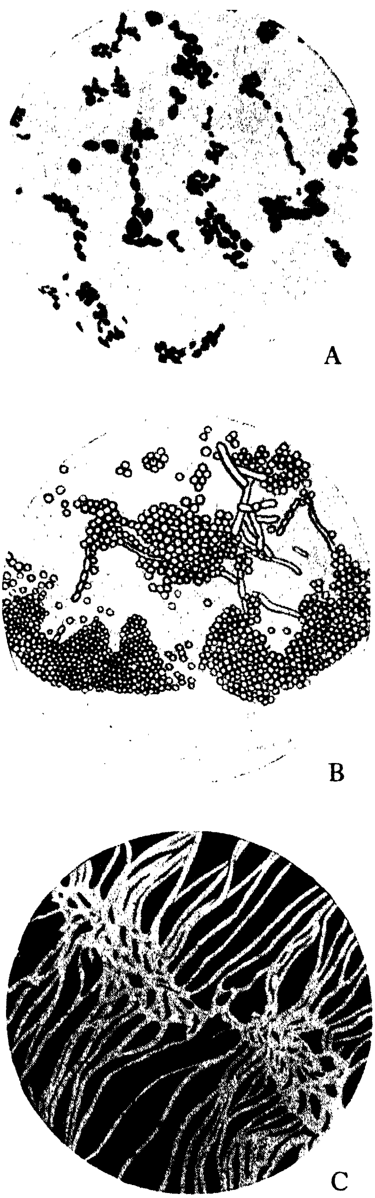
Conditions necessary for bacterial activity	*Examples of methods * used to curb bacterial activity outside the body*
1. Abundance of moisture	1. Drying foods and dishes
2. Protection from ultraviolet light	2. Exposing to sunlight articles used by diseased persons
3. Correct range of temperature for each species	3. Boiling, freezing, pasteurizing, or refrigerating foods
4. Food supply in dilute form	4. Preserving foods in concentrated brine (salt) or thick sugary syrups
5. Neutral or slightly alkaline reaction of surroundings	5. Using strong acids or bases to disinfect articles
6. Usually oxygen in some form	6. Sealing foods in air-tight containers
7. Satisfactory relationships with other microbes in their environment	7. Driving out undesirable bacteria in the intestines by drinking sour milk or buttermilk containing harmless bacteria

* In general, these same methods destroy all microscopic organisms as well as bacteria.

Yeasts and the diseases they cause. A yeast cake contains countless numbers of single-celled yeast plants. They are usually round or oval, and from 20 to 40 times as large as most cocci. They usually reproduce by forming little projections, *spores* (Fig. 149A), which increase in size and break off — a process called *budding*. They are widely distributed in nature, and may be blown about in dust or carried by insects. Most of them are harmless. Some are used in the manufacture of beers and wines.

A few yeasts and yeastlike organisms cause serious and usually fatal diseases in man. One kind causes a serious type of ulcer on the skin or abscesses on the bone and other body tissues. It is not known how yeasts are transmitted except by actual contact with the lesion (sore) in an infected person.

Molds and the diseases they cause. The white, black, or colored growths which commonly appear in old moist bread or other foods are familiar examples of molds. They appear as powdery masses or a mesh work of intertwining threads (Fig. 149C), and have a characteristic "moldy" smell. The air always contains some mold spores (Fig. 149B), because molds set them free in great numbers. When these fall upon food or other



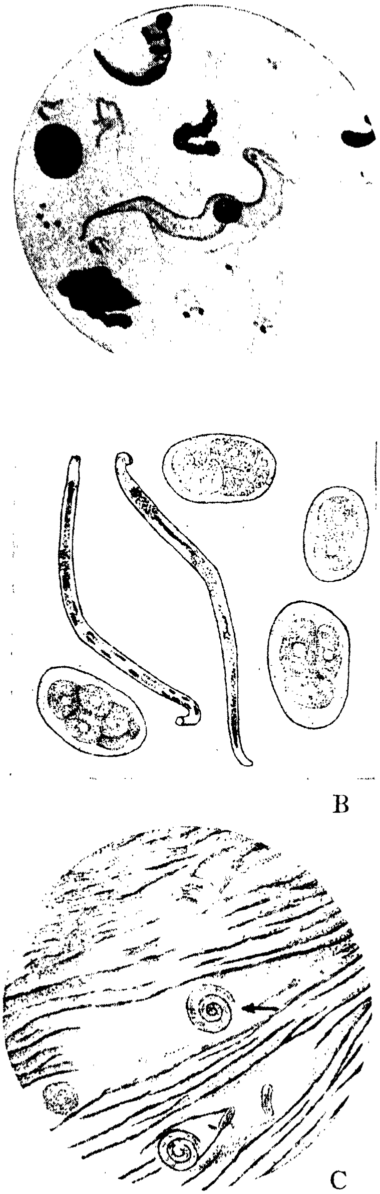
149 *A*. Yeast spores. *B*. Mold The molds shown in *B* and *C* are of the harmless type.

moist, nutritious substances they start to grow. You may reduce the growth of molds by remembering that objects that are clean, dry, cold, or exposed to sunlight do not usually become moldy.

Certain molds (not the harmless ones that grow on food) can grow on human skin and cause *ringworm*, *barber's itch*, "*athlete's foot*," some forms of *eczema*, and other diseases. The molds causing such diseases are probably transmitted mostly by contact with material sloughed off from the infected areas in human beings, though some are thought to be carried by dogs, cats, and other domestic animals.

Protozoa and some diseases they cause. The protozoa are one-celled animals. Many protozoa pass through different stages of development termed the *life cycle*, part of which is spent in the body of a human being and part in the body of an insect. This is the case with the protozoan causing *malaria* and carried by a mosquito, and that causing *African sleeping sickness* (Fig. 150) and carried by the tsetse fly.

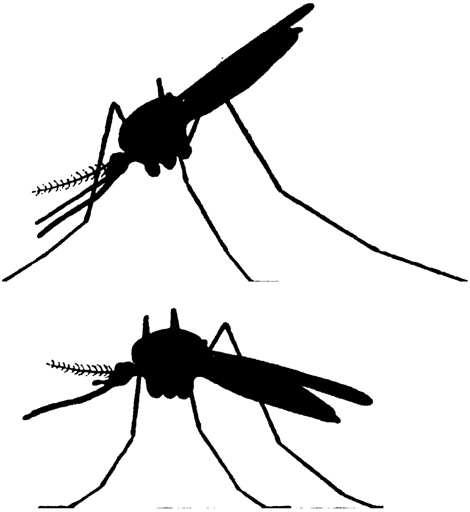
Amebic dysentery is a serious disease caused by a certain species



150 *A*. *Trypanosoma* (causes sleeping sickness). Transmitted by the bite of a tsetse fly. *B*. Hookworm and eggs (page 417). *C*. Trichina (occurs between the muscle cells of hogs). In man it causes serious disease and even death. (Courtesy of Dr. R. V. Stone, Los Angeles County Health Department)

of ameba which lives in the human intestine. It is spread by foods such as lettuce and celery, contaminated from soil fertilized with human wastes or from the unwashed hands of persons afflicted with the disease. Great care should be taken in cleaning all fresh fruits and vegetables. Wash them under running water.

Malaria, one of the most widespread of all human ills, is caused by three species of protozoa, which are carried from one person to another by the female *Anopheles* (Ȧ-nŏf'ĕ-lēz) mosquito. You should be able to recognize this variety, as explained in the caption of Fig. 151. Of course, even an *Anopheles* mosquito is harmless unless she has bitten a person suffering from malaria. The control of malaria in certain parts of the world has been brought about by (1) treatment of all cases with quinine, (2) protection of people against mosquito bites by the use of screens in houses, and (3) destruction of mosquitoes by draining swamps and by putting oil on bodies of water where they breed.



151 The malaria mosquito, *Anopheles*, above, comes to rest in the characteristic position shown here (body at an acute angle to the surface on which the insect alights). The common mosquito, *Culex*, below, comes to rest with its body parallel to the surface. (American Museum of Natural History)

Filterable viruses and virus-produced diseases. Much evidence indicates that certain diseases are caused by tiny bits of unknown substances. Whatever these substances are, they are so small that they will pass through fine filters made of stone and porcelain which strain out all ordinary bacteria from solutions. For this reason they are called *filterable viruses* (vī'rŭs-ĕs). Their presence is shown by the fact that healthy animals will become diseased after injection of unhealthy blood or excretions containing viruses.

Diseases which are supposed to be caused by filterable viruses include chicken pox, smallpox, measles, mumps, infantile paralysis, rabies, common colds, and yellow fever. Most virus-caused diseases are controllable by the methods of hygiene, sanitation, and immunization discussed in the remainder of this problem.

THE PREVENTION OF GERM DISEASES

When any living microbes enter the body, increase in number, and injure the cells in any region, we say that an *infection* [1] has occurred. The abnormal condition produced by an infection is called an infectious disease. It is with such diseases that this section deals.

Most infectious diseases are *communicable*, *i.e.*, they may be transmitted from one individual to another. Hence their control becomes a community problem as well as an individual one. For the sake of others as well as yourself you need to know the nature of such diseases.

The course of infectious diseases. Infectious diseases differ from others in that most of them follow a more or less definite course. The *incubation period* is the time between the entrance of germs into the body and appearance of disease symptoms. The length of this period may be hours, days, weeks, or even months, but it is remarkably constant for each disease. The *period of illness* is accompanied by fever in all germ diseases. The period of *convalescence* lasts from the disappearance of symptoms until complete recovery.

Infected persons may transmit germs to others during certain stages of a disease. The *period of communicability* is known for most diseases, and special care should be taken to protect others during this time. Unfortunately, occasionally an individual harbors germs and transmits them for a long time without actually having the disease. Such persons are called *carriers*. The discovery and control of carriers is one of the most difficult problems in connection with the prevention of diphtheria, scarlet fever, typhoid fever, infantile paralysis, and other communicable diseases.

Where disease germs come from. Germs which cause com-

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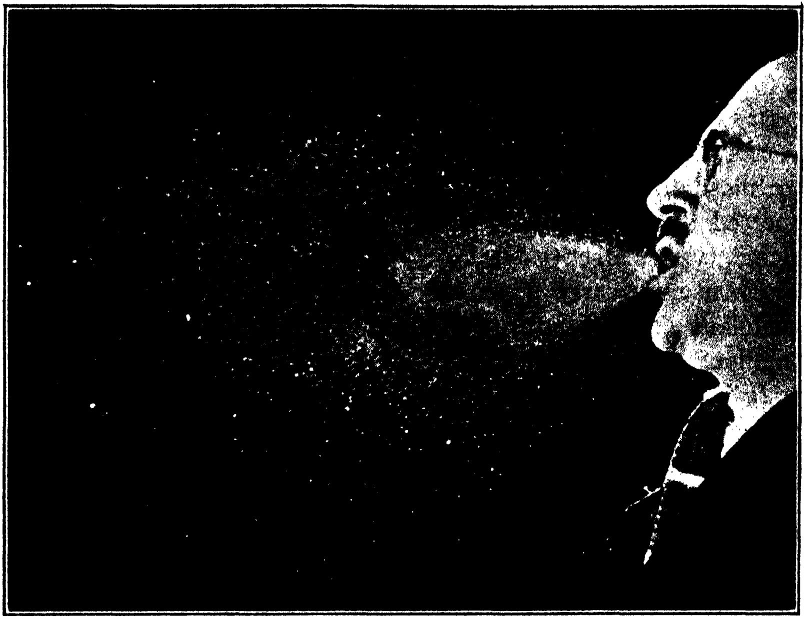
[1] In the glossary, look up the meaning of *acute*, *chronic*, *local*, *focal*, *generalized*, and *latent*, as used in connection with infections.



152 A photograph of a sneeze. This high-speed photograph made by Professor Marshall W. Jennison, of the Massachusetts Institute of Technology, shows a cloud of minute droplets "stopped" in full flight at the climax of a sneeze. The moisture in the droplets quickly evaporates, leaving thousands of germ-laden particles of matter from the nose and throat floating in the air. (Acme)

municable diseases cannot live very long outside the bodies of their hosts. Water, food, and other substances contain disease germs *only* when freshly contaminated with the body discharges of infected persons, as follows:

Discharges from nose and throat may carry germs and viruses for colds, measles, mumps, chicken pox, smallpox, whooping cough, influenza, pneumonia, pneumonic plague, diphtheria, scarlet fever, septic sore throat, infantile paralysis, tuberculosis, and syphilis.

Saliva [1] may carry all organisms found in nose and throat discharges, and virus of rabies.

Sputum may carry germs for tuberculosis, whooping cough, influenza, pneumonia, and pneumonic plague.

Secretions from eyes may carry germs of trachoma and conjunctivitis (often spread by common towels).

[1] Saliva is probably the commonest spreader of germs. Remember this when tempted to take "bites" of other people's food.

Discharges of pus from ears, boils, or throat abscesses may spread similar infections.

Secretions from lesions of skin and mucous membranes may carry germs of smallpox, leprosy, gonorrhea, and syphilis.

Blood may contain germs of malaria and yellow fever (carried by mosquitoes), plague (carried by rat fleas), Rocky Mountain spotted fever (carried by ticks), tularemia (carried by flies and ticks), typhus fever (carried by lice).

Urine may carry germs of typhoid fever, paratyphoid fever, undulant (Malta) fever, tuberculosis (of kidneys), and possibly smallpox.

Intestinal excretions may carry germs of typhoid fever, paratyphoid fever, dysentery, tuberculosis (especially in cattle), anthrax, and possibly infantile paralysis and smallpox. Hookworms, tapeworms, and other animal parasites are also found in these excretions.

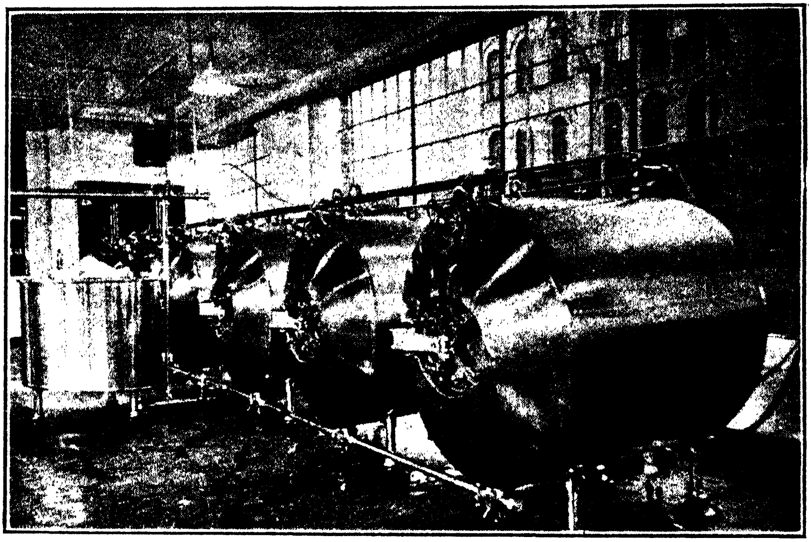
How disease germs are transmitted. Communicable diseases are spread from one person to another chiefly by the following means:

1. *Direct* bodily contact with sores in the skin or mucous membranes of an infected person or animal.

2. *Indirect* contact with articles contaminated by a diseased person or carrier. Common sources are food, dishes, silverware, handkerchiefs, towels, toilet articles, bed clothing, or anything used or touched by a diseased person. Because you frequently come in contact with contaminated articles in public places when you least expect it, form the habit of keeping your hands away from your mouth, nose, and eyes; always wash your hands with soap and water before eating. The importance of clean hands cannot be overemphasized.

3. *Droplet infection from the spray of coughing or sneezing.* Always cough or sneeze into a handkerchief and avoid people who are apt to spread germs by this means (Fig. 152).

4. *Water* — especially from open wells and streams. This may be polluted by the intestinal discharges of men and animals. It is then dangerous because it may contain the germs of such diseases as typhoid fever, dysentery, and cholera. Present methods of sewage disposal and water purification have made these diseases



153 Pasteurization makes for extra safety. These huge tanks are equipped with a special recording thermometer that charts the temperature and time the milk is pasteurized. (Courtesy of Borden's Farm Products)

rare except in rural communities. In emergencies and when camping, play safe by boiling the water for 15 minutes, then shake it in a bottle to remove its flat taste.

5. *Milk.* A great variety of bacteria are able to live and multiply in milk. If cattle are not healthy, if unsterilized milking utensils are used, or if the hands of infected persons come in contact with milk, it may contain the germs of tuberculosis, undulant (Malta) fever, typhoid fever, and other diseases.

The problem of making such milk safe for use has been solved by *pasteurization* (Fig. 153), a process of holding milk at a temperature of about 142° F. and then cooling it rapidly. Pasteurization destroys all disease-producing organisms.

"Certified milk" is supposed to be the purest *raw* milk. Although the most rigid standards of cleanliness are specified for its production, inspectors find it difficult to determine whether all of the requirements are being met at all times. Therefore, it may be said that the only milk which can be guaranteed to be free from germs is freshly pasteurized milk.

6. *Other foods.* The foods which most commonly transmit in-

fection are those which are eaten raw and may have been infected. Important among these are milk, butter, cheese, ice cream, fresh vegetables, and shellfish. It naturally follows that other foods, especially pork (Fig. 150C) which have been only partially cooked, are also dangerous. Foods that are thoroughly cooked are free from bacteria.

7. *Bites of flies, mosquitoes, lice, fleas, ticks, and other insects.* These may carry the diseases listed under "Blood," on page 414. The most effective methods of controlling insect-borne diseases are: (1) destroy the breeding places of the insects; and (2) protect persons in various ways from their bites.

8. *Infection from soil.* Direct contact of wounds with soil containing germs of *lockjaw* (Fig. 148D) and *gas gangrene* is rare but very dangerous.

How disease germs enter the body. There are five avenues of entry into the body for disease germs and it is these "gates" that you must guard. They are: (1) the delicate membranes surrounding the eyes, (2) the respiratory tract, (3) the digestive tract, (4) the skin, when broken by cuts or insect bites, and (5) the genito-urinary system consisting of the urinary system and the reproductive organs. Be careful to keep these germ entrances especially clean at all times, and free from all possible contaminated articles, including fingers.

METHODS OF HELPING THE BODY TO RESIST GERMS

You learned, in the previous section, the general principles for keeping dangerous microbes out of the body. Your body itself also has three remarkable lines of natural defense against germs. In addition, scientists have discovered artificial means of protecting you from certain diseases.

Natural protection against germ entrance. (1) The *skin* is germproof so long as it is kept unbroken. (2) The *lining tissues* of body entrances, especially the mouth and alimentary canal, are quite resistant to infection, if kept in a normally healthy condition. (3) *Bile* and *digestive juices* aid somewhat in defense by retarding the growth of bacteria. (4) The *respiratory tract* offers a strong resistance in several ways: the nasal secretions are slightly germicidal; cilia of the windpipe catch and eject many germs; and certain cells of the lungs actually destroy some germs much as white corpuscles do. (5) Infection through the *eyes* is largely prevented by their constant cleansing with tears.

Special weaknesses in your protective barrier. Various parts of the body are subject to attack only by certain kinds of diseases. For instance, it has been proved that typhoid germs can invade only the cells of the intestines while diphtheria germs attack only the throat.

Although hookworms grow only in the intestine, they reach their goal by a roundabout method. This disease is especially prevalent in some rural sections where people go barefoot in the fields. The tiny worms (Fig. 150B) from feces of infected persons pierce the skin of a healthy person and by way of his blood stream, lungs, bronchial tubes, and esophagus, they finally reach the intestines, where they grow and cause the symptoms of the disease.

General resistance to disease. If germs pass your natural barriers, they meet the following strong defenses: (1) Owing to its *vitality*, every living cell offers a certain resistance. Living protoplasm resists bacteria, but as soon as it dies these bacteria invade it and cause it to decay. In your body, many germs are harmless unless they can find some broken-down tissues to grow in. (2) If cells are well nourished, they have no affinity for disease germs. Lowered resistance due to poor cell nutrition may be caused by an actual deficiency in the diet or by improper digestion or assimilation (from insufficient rest, overwork, and worry). (3) The *blood* has germ-destroying properties. Certain substances in it dissolve and alter bacteria so as to make them harmless, while white corpuscles engulf and destroy germs and other foreign particles.

How to maintain a high general resistance. Resistance to certain diseases depends somewhat upon age and race, but in general you can maintain high resistance by: (1) proper food, plenty of rest, and other hygienic measures; (2) regular and temperate habits in all things; (3) constructive mental states such as peace of mind, courage, and happiness; (4) an occupation that you like and that will allow you to be outdoors every day; and (5) sanitary, pleasant surroundings in which to live.

Some of the specific things which lower resistance are: diets deficient in vitamins, excessive fatigue, insufficient sleep and rest, undue exposure to extreme heat or cold, prolonged hunger or thirst, continuous worry or other negative mental states, alcoholism, addiction to drugs, and disease itself.

How the body resists specific disease germs. When microbes overcome the natural germ-killing power of the blood and multiply rapidly, the body falls back on its last line of defense. It forms specific substances, called *antibodies*, which combat the invading microbes. Recovery from most germ diseases depends upon forming enough of these in the body to overcome the germs and their toxins. The body forms two types of antibodies: (1) *antitoxins*, which neutralize soluble toxins formed by certain bacteria, and (2) *antibacterial antibodies*, which react directly upon certain bacteria.

In combating a certain bacterial disease which the body naturally fights by the formation of antibodies a patient may be helped by injecting into his blood a serum which contains the specific antibodies for that disease. Diseases which may be treated in this way include diphtheria, scarlet fever, lockjaw, and bites by poisonous spiders and snakes.

Natural immunity. When certain racial groups of people are exposed to a disease continuously over a long period of time, they develop a considerable degree of natural immunity to that particular disease. Thus the Caucasian race in general, and Jewish people in particular, are more resistant to tuberculosis than are Negroes and Indians at the present time.

Acquired immunity. Persons who recover from diseases such as measles, smallpox, whooping cough, infantile paralysis, plague, or yellow fever usually have developed more antibodies than needed to fight the disease. Enough of these substances remain in their blood to make them immune to further attacks of the disease.

Through years of painstaking labor in developing immunizing agents, such men as Pasteur, Jenner, and others, have practically freed mankind from some of the most dreaded diseases. Artificial immunity to such diseases as smallpox, diphtheria, typhoid fever, and rabies is acquired by the use either of *vaccines* or of *immune serums*. Vaccines are composed of dead or weakened germs or of toxins which, when introduced into the body, stimulate an individual to develop his own specific antibodies. An *immune serum* is the serum (see page 114) of the blood of a human being or of an animal who has recovered from a disease. Therefore it contains the specific antibodies of that disease. When an immune serum is injected into a person, these antibodies make him immune to that particular disease.

Practical aspects of immunization. Governments have recognized the value of immunizing vaccines and serums in saving life to such an extent that soldiers are compelled to be immunized against smallpox, typhoid, tetanus, yellow fever, and diphtheria. Individuals are increasingly recognizing the advantages of having themselves and their children safeguarded in the same way.

Children have a right to be protected against certain diseases which are particularly dangerous to life, impair their health and strength, or leave them weakened in some way for life. Among such diseases diphtheria and scarlet fever are most dreaded. Fortunately, the *Schick* test for diphtheria and the *Dick* test for scarlet fever show whether a person is immune to these diseases. Every child should be given these simple and harmless tests, and if necessary be immunized by the time he is a year old, for the most susceptible period is between the ages of one and four years.

Whooping cough is another devastating disease easily and harmlessly prevented by a vaccine. Parents who realize the possibilities of weakened lungs and greater susceptibility to pneumonia and tuberculosis as a result of this disease will not allow their children to have it. Measles also is more serious than most people suspect and may often be prevented or made less severe by the use of a serum after exposure to the disease. Vaccination against smallpox is usually given unless the physician advises otherwise.

Of course, no informed person would depend upon such immunizing methods alone for protection. Under no circumstances can you afford to disregard the laws of health, cleanliness, and sanitation, in preventing the spread of disease. Remember, also, that the effectiveness of many serums depends upon their early administration. Hence the most important thing to do for a person who has been exposed to infection or who has symptoms of a bacterial disease, is to call a doctor immediately. *The early diagnosis and treatment of an illness often means the difference be-*

tween a mild and a severe attack of the disease, or the life and death of the patient. This fact cannot be repeated too often.

THE PREVENTION OF SOME SPECIFIC DISEASES

A few diseases, both communicable and noncommunicable, are so prevalent that you should know how to protect yourself against them. The exact cause and cure of most of these are not yet fully understood and much research is being done on them continually. You can at least take advantage of what has already been learned concerning them.

The common cold. The theory has been commonly accepted lately that colds are caused by a virus which attacks the mucous lining of the respiratory passages. It seems also that the virus is present at all times but becomes active when a person's resistance is lowered.

The *prevention* of colds then appears to be: (1) to prevent the spread of the virus from those who have colds, especially through coughing, sneezing, or talking close to anyone; (2) to maintain a healthy condition of the lining of the nose and throat; and (3) to keep the bodily resistance high. (See page 417.)

An even body temperature seems particularly important in resisting and curing colds. Sitting with cold or damp feet, or sudden chilling of the skin as from a draft or rapid cooling when you are damp with perspiration sends more blood to the head, congests the capillaries of the nasal membrane, and makes this area fertile ground for an attack from cold germs.

The time to *treat* a cold is when you first feel any slight symptom of it. After it is well started you may as well let it "run its course." If you treat it early, however, you may break it up in two or three days, or even over night. The general principles to keep in mind are: (1) get warm and stay warm, (2) stimulate circulation and elimination by every means you can, and (3) get rested as quickly and completely as possible.

Some specific ways of accomplishing these goals are: (1) drink large quantities of liquids, especially fruit juices and a soda-lemon drink[1]; (2) take a warm-water enema with one teaspoonful of salt

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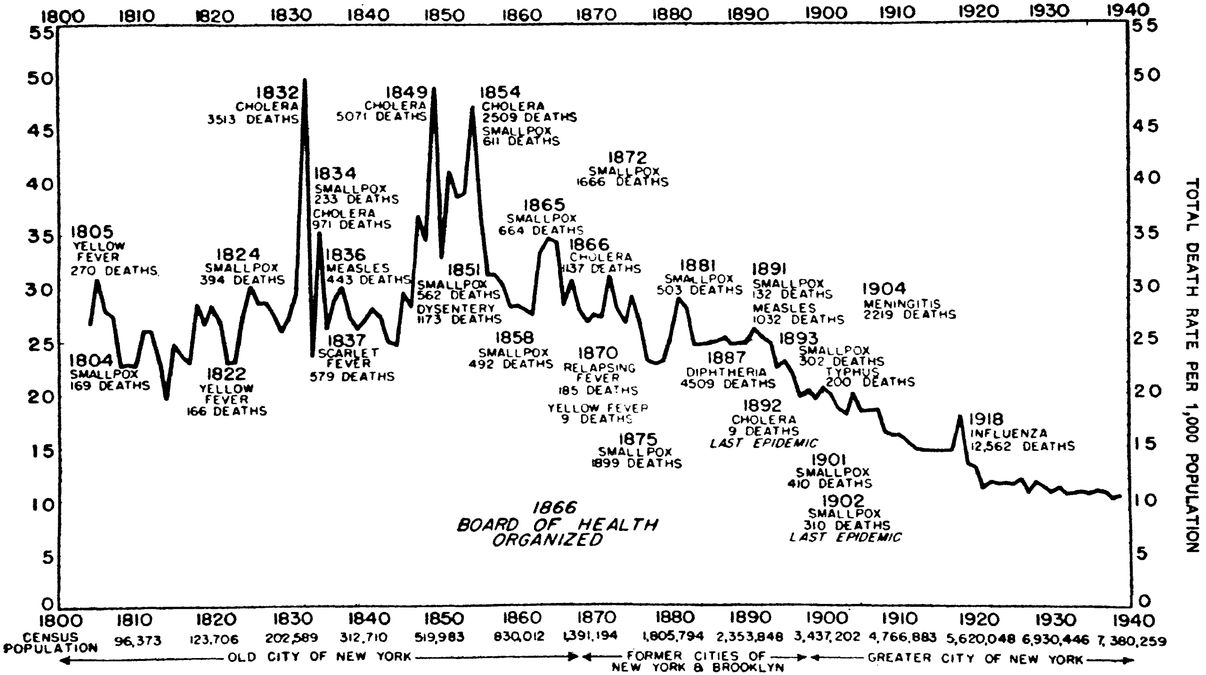
[1] Put the juice of one lemon and one teaspoonful of bicarbonate of soda in a quart jar. Shake down bubbles, then fill jar with warm water and drink quickly.



154 The conquest of pestilence in New York City. Many large cities have made similar progress. Note that the peak years have declined in number and intensity. (Courtesy of the Board of Health, New York City)

per pint or a mild laxative such as mineral oil or milk of magnesia; (3) gargle a tumbler full of water (as warm as you can stand it) into which have been dissolved one teaspoonful each of salt and soda; (4) use only such nasal drops and sprays as your physician recommends for *you;* (5) breathe *deeply* of fresh though not cold air; and (6) perhaps most important of all, take a warm bath and go to bed immediately. Cover up warmly. Perspiring is helpful, but be careful not to chill. *Remain in bed until you are well!*

Many diseases such as measles, whooping cough, and infantile paralysis start much like a cold. Also, colds that aren't properly cared for often develop into more serious conditions such as mastoid infections, sinus infections, bronchitis, influenza, or pneumonia. Hence, every cold should be taken seriously and given good care. Symptoms which indicate that dangerous conditions may be developing are: fever, acute earache, sore throat that lasts more than a few hours, severe tightness in the chest, difficulty in breathing, and pains in the back and legs. *If any of these symptoms appear, call a doctor immediately.*

Influenza. This disease also seems to be caused by a specific virus. The first symptoms may be those of a cold, but the patient develops fever and severe backache. A person thus afflicted should go to bed at once and call a doctor. This, in most cases, will prevent complications, commonest of which is pneumonia. After recovery the patient is very weak and is likely to bring on a relapse or damage to his heart if he gets up too soon.

Pneumonia. This disease, too, ranked high among the causes of death until the recently discovered "sulfa" drugs (sulfanilamide and its derivatives) proved highly effective for its cure. Death from it now occurs chiefly in extreme youth and old age or in cases not properly treated. Since it usually occurs in those who have been weakened by a cold or other infectious disease, its best preventive is proper care. The symptoms of pneumonia are chills, fever, cough, pain in the chest, and blood-tinged sputum. If any of these symptoms appear, the patient should go to bed immediately and stay there, and a doctor should be called at once.

Tuberculosis. The *tubercle bacilli* (Fig. 148C), which cause this disease, may invade any part of the body. The most common seat, however, is in the lungs. The body attempts to defend itself against these germs by forming a capsule around them. This prevents their spread into healthy tissue and in most cases the germs die. Examinations show that 75 per cent of all of us have been infected at some time in our life (usually in childhood) and probably did not even realize it. Sometimes, however, the bacteria remain alive. In individuals whose bodily resistance is low, the protective wall may give way and the germs renew their activity.

155 This girl is being tested for tuberculosis. If the test reacts positively, an X-ray photograph will be necessary to determine whether the germs are active. (Courtesy of Los Angeles Board of Education)

A simple test (Fig. 155) reveals any tuberculous infection. This test, given to all school children is one of the best ways of controlling the disease, for it permits early detection and treatment of the disease and prevents the spread of infection to others.

Prevention of tuberculosis consists largely in avoiding infection from tubercular persons or from milk or other sources, and by avoiding the lowering of resistance. Persons between 12 and 18 years of age need especially to safeguard their health in every way possible, for the changes taking place in their bodies make them more susceptible to tuberculosis at that time than during any other period of their lives.

Cancer. Although the exact cause of cancer is still unknown, scientists are certain that it is not a germ disease and hence is not communicable. Neither is it hereditary, though a susceptibility for it seems to be inheritable.

In cancer some cells of the body grow wildly, multiplying faster than normally and destroying other cells that are near. Often these cells develop into a large mass or tumor. The growth may

156 Cancer responds to treatment. One of the main methods of treating cancer today is shown above. Here you see a patient under the 250,000-volt X-ray machine, which directs curative rays into the growth. (Courtesy of *Friday Magazine*)

be rapid or slow and it may be within the body or on its surface. *In its early stages cancer is curable* by radium, X-ray treatments, or surgery.

Here again, cure depends upon early diagnosis and treatment. Some symptoms which may or may not indicate cancer but which reveal the necessity for at least a complete examination by a physician are: the presence of a lump, rapid growth of a mole (page 251), a sore that does not heal readily, especially if on the lip, constant internal pain, persistent bleeding, or an unexplainable loss of weight. If the examination reveals a cancer, the patient has a chance to be cured; if it proves that there is no cancer, it will have been worth the cost by setting the mind at ease.

Allergies. For some reason as yet not satisfactorily explained, many people are sensitive to or are "poisoned" by certain foods or by substances inhaled. Such a sensitivity is called an *allergy.* The results of allergies are sometimes hay fever, asthma, sinus disease, hives, or indigestion. The only sure way to determine a specific allergy is by special tests with various foods, pollens, dusts, etc. Such tests are made either by the "scratch method" or by electrical means. They are of great value, for the patient will be cured of his ailment as soon as he avoids the specific agent which causes his allergy.[1]

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[1] If you are allergic you will enjoy and profit by reading Harry S. Bernton's *What to Do about Hay Fever,* Rousdell, Washington, D.C., 1939.

COMMUNITY PROBLEMS IN DISEASE PREVENTION

At some time you probably have faced the problem of trying to stay healthy when other members of your family had a cold, or when large numbers of your schoolmates were suffering from some infectious ailment. If so, you realize that health is more than a personal problem. In fact, the entire modern world is so closely related by commerce and travel that health conditions even in foreign countries sooner or later affect us at home. Consequently, you will want to be informed as to the major health problems affecting your local community, your state, and your nation. You will also want to learn how you can help to solve these problems.

Pure water. If you have ever gone camping you will have learned to appreciate your home-community water supply. Yet the problem of providing good water is not merely one of piping it into homes, but of making sure that it is pure. Usually this is done by adding just sufficient ozone, chlorine gas, or chlorinated lime to the water to kill bacteria without damaging human health or affecting the taste of the water. Impurities other than germs are usually removed by filters or settling tanks.

Typhoid bacilli and other harmful bacteria are carried by water. Hence rivers, lakes, reservoirs, and wells that serve as sources of water supply should be guarded carefully against pollution. The water should be tested daily by city or county authorities for the presence of harmful bacteria and chemicals. Clearness of water does not guarantee purity, for bacteria and poisonous minerals cannot be seen without a microscopic or chemical examination. Water sometimes is hard because of certain minerals dissolved in it, but this fact alone does not make it unfit to drink.

Pure food. Laws and health authorities can do much to safeguard your food supply, but much also depends on you. The Federal Food, Drug, and Cosmetic Act requires factory inspection and informative labeling of packaged foods and drugs. It does not prohibit the use of injurious substances, but merely requires that they must be mentioned on the label. *You* must read and understand the label.

Fresh foods are in danger of contamination by dust, flies, roaches, dogs, cats, and human hands. Although health officials inspect for such conditions, their inspection tours may be far apart. Every individual who handles food in marketing or preparing it must do his part to see that it is kept clean. All such persons should be required to pass a health examination and should be particularly careful of their personal habits such as washing the hands frequently, especially after using the toilet. Customers should never be permitted to handle food materials.

Meat may carry trichina worms, tapeworms, and the germs of tuberculosis, anthrax, botulism (food poisoning), and paratyphoid fever. Animals should be inspected before and after they are slaughtered in order to eliminate diseased ones. Federal authorities inspect only meat that is destined for interstate trade; local authorities should provide thorough inspection service for intrastate sales.

All food factories, stores, and restaurants should be subject to rigid inspection. They should be required to keep everything in a sanitary condition, and to sterilize all dishes and silverware used by customers.

Healthful milk and milk products. For many reasons the production and distribution of milk constitutes a major health problem of the community. Milk, when used uncooked, provides a good medium for many bacteria. It sours quickly; often it must be transported long distances; it must be retailed in small quantities; and it has many chances of becoming contaminated. Dairies usually are inspected regularly by health officers (in some localities daily). Items checked are: the health of the cows; the health of milkers and milk handlers; and the sanitary conditions at each step in its production, transportation, and sale. Even though milk is to be pasteurized (see page 415), it should be produced under sanitary conditions. Flies should never be allowed near the milk; persons with cough, cold, or other disease symptoms should never handle it; and it should be kept below 50° F. when transported more than a short distance.

Safe disposal of sewage. By far the most important health problem a community faces is that of disposing of sewage. Human body wastes from the colon and bladder are the most dangerous and objectionable of all wastes. They spread such diseases as typhoid fever, cholera, infant diarrhea, dysentery, and hookworm. Even

157 In modern, sanitary dairies human hands do not come into contact with the milk; each bottle is filled, capped, and sealed by machine. The men at the right inspect every bottle before it is put in the case. (Courtesy of Borden's Farm Products)

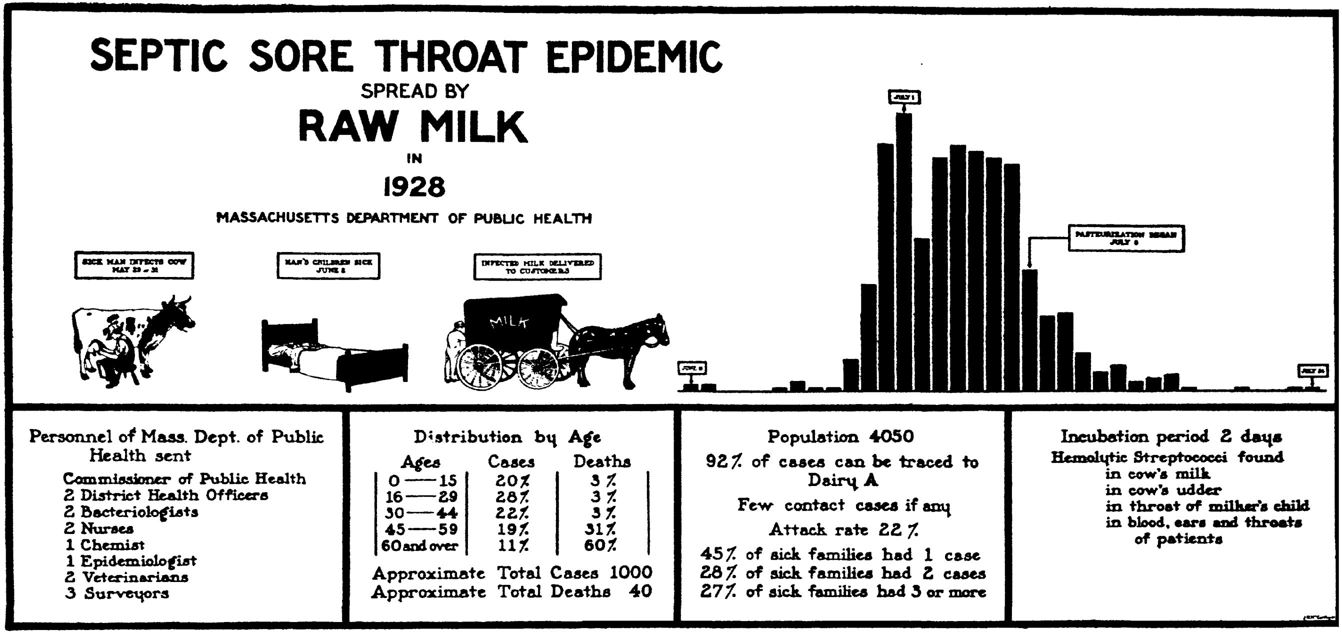
in the present "civilized" age hundreds of thousands of cases of these diseases are spread yearly by sewage.

The chief principles in sewage disposal are: (1) surface soil must not be polluted by wastes[1]; (2) sewage must not be allowed to pollute underground water that later seeps into wells or streams; and (3) no flies should be permitted to come in contact with wastes.[2] Rural communities, especially, need rigid inspection to see that these conditions are fulfilled. Isolated homes without running water should use chemical toilets if possible, or at least keep outhouses and vaults absolutely flyproof.

Cities usually purify sewage by chemicals such as strong acids or alkalies, or lime, or by bacterial action. Most cities use two or more of the several methods known. The process requires good engineering and an expensive plant, but its value to the community and to distant localities affected by it is inestimable. After sewage is thoroughly purified, it may be poured with perfect safety onto farm land or into lakes, rivers, or ocean.

[1] Hookworm is acquired chiefly from soil, yet in some localities as much as 90 per cent of the population is infected! Dysentery is often spread by vegetables grown on polluted soil.

[2] It has been demonstrated that even stables and dairies can be kept practically flyless by *daily* removal of manure and treatment of floors with borax solution.



SEPTIC SORE THROAT EPIDEMIC
SPREAD BY
RAW MILK
IN
1928

MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH

Personnel of Mass. Dept. of Public Health sent

- Commissioner of Public Health
- 2 District Health Officers
- 2 Bacteriologists
- 2 Nurses
- 1 Chemist
- 1 Epidemiologist
- 2 Veterinarians
- 3 Surveyors

Distribution by Age

Ages	Cases	Deaths
0——15	20%	3%
16——29	28%	3%
30——44	22%	3%
45——59	19%	31%
60 and over	11%	60%

Approximate Total Cases 1000
Approximate Total Deaths 40

Population 4050

92% of cases can be traced to Dairy A

Few contact cases if any

Attack rate 22%

45% of sick families had 1 case
28% of sick families had 2 cases
27% of sick families had 3 or more

Incubation period 2 days

Hemolytic Streptococci found
in cow's milk
in cow's udder
in throat of milker's child
in blood, ears and throats of patients

158 This chart bears careful study. Follow the true story it tells. Note how and when one man started an epidemic. How was the spread of disease checked, beginning July 8? (Courtesy of Massachusetts Department of Public Health)

The garbage question. Although garbage does not "breed disease," it does attract and breed flies and other pests, and gives off disagreeable odors. Many cities use large incinerator plants to dispose of garbage by burning it. When camping, bury your garbage and cover with a screen to prevent animals from digging it up. If you live in a rural community you may feed garbage to hogs or chickens, or you may drain it thoroughly, wrap in newspapers and burn it by throwing it on a very hot fire.

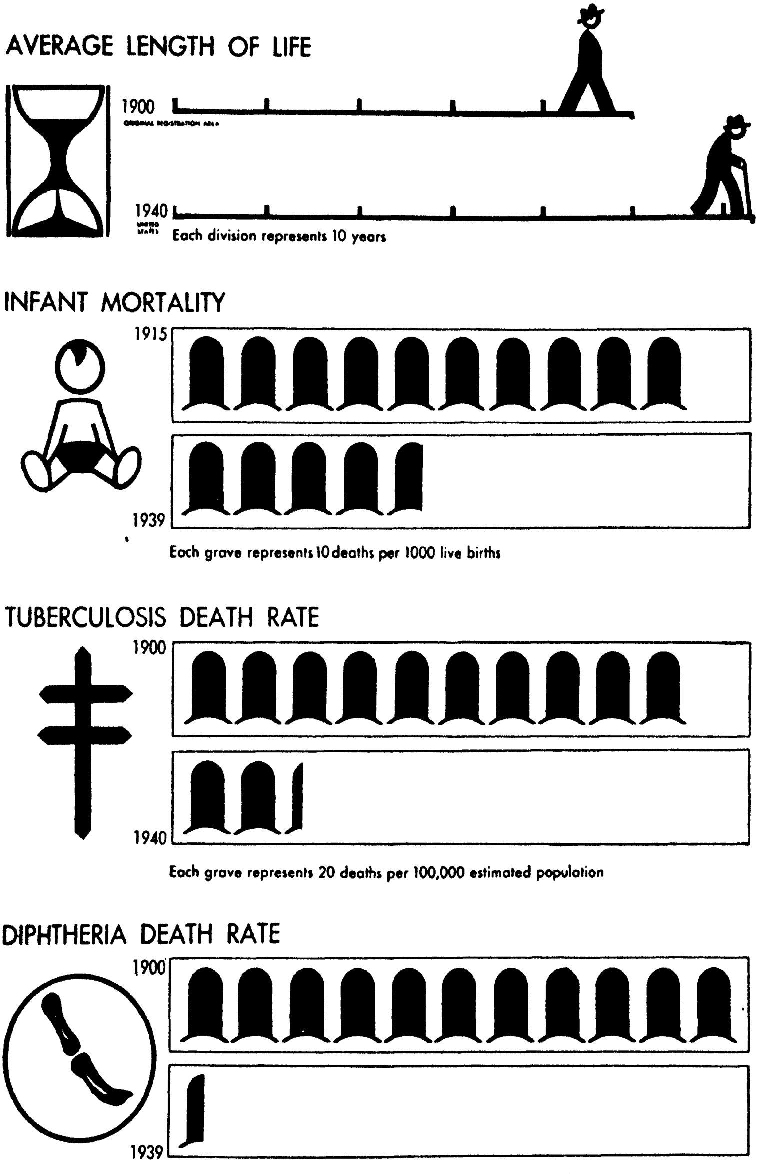
If you live in a city which has garbage collection, place refuse in a watertight covered can lined with newspaper. After the can is emptied, always wash thoroughly and let dry (in the sun, if possible), and reline with fresh newspapers. Occasionally wash the can with a disinfectant solution.

Co-operative war against germ-bearing insects. Every member of a community would doubtless gladly participate in the war against destructive insects if he realized the seriousness of the problem. Besides the insect pests that destroy crops, gardens, food, clothing, and furniture, many others spread deadly diseases. Flies breed in filth, and spread typhoid, dysentery, and other intestinal diseases; one type of mosquito carries malaria, and another, yellow fever; body lice spread typhus fever; and rat fleas carry plague germs.

Each type of insect must be combated in a special way which requires the concerted efforts of the whole community under the direction of someone with authority to enforce action. Flies must be controlled by strict cleanliness of homes, restaurants, streets, parks, and public buildings, as well as barn yards and dairies. Mosquitoes can be eradicated only by draining swamps or filling, oiling, or screening pools of water. Ornamental ponds should contain mosquito fish (*Gambusia*) which will keep them free of mosquito larvae.

Fleas carry the deadly Bubonic plague to humans from infected rats. Hence the control of this disease (still present on all continents of the world) consists almost wholly in eradication of rats and other rodents. No household should tolerate rats. They may be trapped, poisoned, or hunted. Most modern cities require that the foundations of buildings be ratproof.

AMERICA'S HEALTH RECORD



PICTOGRAPH CORPORATION

From Eckenrode, Morgan, Corson, THIS GOVERNMENT, Johnson Publishing Company

Other community health problems. Perhaps you already feel that public-health agencies must be pretty busy, but there are still more health hazards for them to control.

Barber shops and beauty parlors must be inspected to see that special precautions are observed to assure cleanliness and sterilization of instruments and towels. Customers should be alert and insist on proper sanitary procedures.

Public buildings, stores, factories, and streetcars require supervision to guarantee clean and sanitary surroundings. Their special supervision by health authorities will be necessary as long as citizens remain ignorant, thoughtless, or selfish. Every community should also provide conveniently located rest rooms which are sanitary and well-kept at all times.

Schools in particular must establish every possible health safeguard such as adequate toilets and wash bowls with soap and towels — these in sufficient number and so placed as to serve conveniently the needs of all. Every pupil should be responsible for keeping the school buildings and grounds sanitary and livable.

No community can overlook the responsibility for providing wholesome and safe recreation under sanitary conditions. Public parks, playgrounds, swimming pools, gymnasiums, libraries, community recreation halls, public-camp grounds — all these, when properly supervised, add to the physical and mental health of the members of the community, and are justifiable expenditures of public funds. If not well kept, however, they become danger spots in the community. The swimming pool, for instance, can spread disease rapidly unless the water is treated with chlorine, and changed continuously. It should be tested several times daily.

Caring for communicable-disease patients. Our present scientific knowledge makes it possible to control many communicable diseases by merely isolating the patient and permitting no one to contact him except his nurse. This nurse should take special care to destroy all excretions from the patient immediately and to sterilize all eating utensils, wash cloths, towels, etc., used by him. The nurse must also be scrupulous about keeping her own hands thoroughly clean. After the patient has recovered, everything he has touched should be sterilized or burned, and the room should be well aired and the bedding sunned.

Some of the diseases which require isolation are influenza, chickenpox, dysentery, measles, mumps, trachoma, tuberculosis, whooping cough, and rabies (both human and animal). Anyone with a cold would do well to isolate himself the first three days. Certain diseases, however, require that all persons exposed to the disease be *quarantined* until they have passed the time when they might be expected to show symptoms of the disease (*incubation period*). Some of the commonest of these diseases are cholera, measles, scarlet fever, meningitis, infantile paralysis (poliomyelitis), plague, smallpox, typhus fever, and yellow fever.

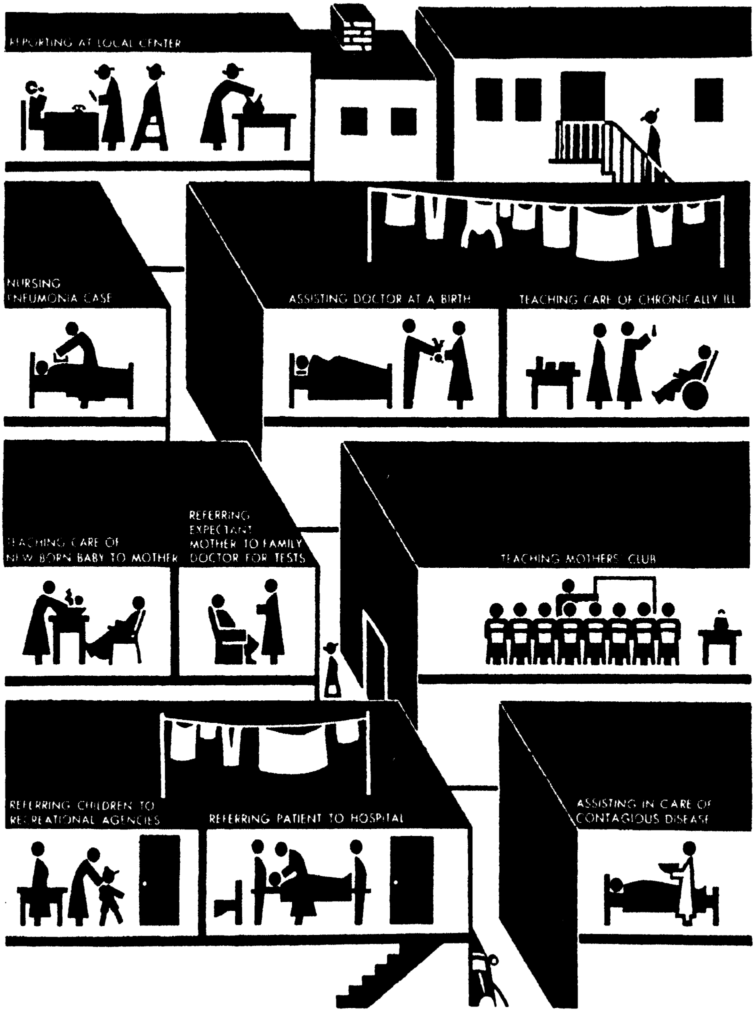
All communicable-disease cases should be reported to the health authorities immediately and their instructions followed exactly.

The importance of housing. If you have ever lived through a flood, fire, war, or other catastrophe where large numbers of people were concentrated in camps or other temporary living quarters, you have become acutely aware of the importance of safe and adequate housing. In crowded, unsanitary conditions, epidemics are common, for it is practically impossible to prevent the transfer of germs from one person to another. Emergency camps should have the direction of the best sanitary engineers available and the intelligent co-operation of every individual in them if serious disease conditions are to be avoided.

We need not wait for emergencies to reveal such dangers to us, however, for similar though less acute conditions exist in the "slums" of many cities. Many tenements have little or no sunlight and fresh air and no running water. Many have no bathtubs or only *un*sanitary ones, which are used in common by many families. This breeds diseases which affect not only the inhabitants of these districts but others as well, through contact in public places. The provision of clean, healthful homes for everyone is a public problem as well as a private one.

How communities organize to protect health. Modern communities hire trained specialists to oversee their health work. The number of persons needed depends on the community they serve. A single trained health officer and nurse may be sufficient for a rural district, but a large city or county needs many sanitary engineers, physicians, public nurses, bacteriologists, special inspectors, and other specialists.

WORK OF A VISITING NURSE


REPORTING AT LOCAL CENTER
NURSING PNEUMONIA CASE
ASSISTING DOCTOR AT A BIRTH
TEACHING CARE OF CHRONICALLY ILL
TEACHING CARE OF NEW BORN BABY TO MOTHER
REFERRING EXPECTANT MOTHER TO FAMILY DOCTOR FOR TESTS
TEACHING MOTHERS' CLUB
REFERRING CHILDREN TO RECREATIONAL AGENCIES
REFERRING PATIENT TO HOSPITAL
ASSISTING IN CARE OF CONTAGIOUS DISEASE

PICTOGRAPH CORPORATION for Picture Fact Associates, NURSES, Harper and Brothers.

159 Visiting nurses provide direct service and bring medical advice from the outside to many families who cannot afford adequate care. Sometimes supported by private endowment, visiting nurses in many cities are paid out of public funds.

The work of health departments in general consists of: (1) medical services such as clinics of several kinds, public physicians and visiting and school nurses, school doctors and dentists to examine all school children periodically, immunization for prevention of smallpox and diphtheria, and many similar services; (2) control of health conditions including inspection of food, milk, water systems, sewage and garbage disposal, housing conditions, stores, and the control of nuisances such as smoke, dust, unnecessary noise, and disagreeable odors from tanneries, dairies, and factories; (3) educational and publicity services carried on through newspapers, radio, and schools.

Many public-health departments do not now cover all these fields because they are hampered by obsolete laws or insufficient tax funds or an unintelligent, nonco-operative public. What duties does the health department in your locality perform? How up-to-date are your health laws and regulations?

State health departments aid local ones and handle health problems throughout the state. Numerous federal agencies deal with various aspects of national health. Some of these are the United States Public Health Service in the Treasury Department, the Children's Bureau, the Bureau of Mines, the Bureau of Home Economics, the Division of Meat Inspection, the Dairy Division, and the Social Security Board. At the present time it is a much-debated question as to whether these agencies should all be under one federal health department with its director in the president's cabinet. Certainly the American people are coming more and more to realize that the health of *all* is the concern of *all*, and that "funds properly spent for the prevention of disease and for medical care are the soundest of all possible national investments." [1]

Recently the term "socialized medicine" has sprung into prominence. In some cases socialized medicine takes the form of medical groups or clinics under private control; in some under school or other public-agency administration; in some through co-operative agreements between doctors and a central office whereby subscribers may select physicians from an available list, sponsored by state or county medical associations; in some the tendency is toward government- or state-controlled medicine. The general principle underlying all such plans is that the subscriber pays a fixed fee monthly or yearly, for which he receives all necessary medical, surgical, and possibly hospital service.

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[1] De Kruif, Paul, *Health Is Wealth*, Harcourt, Brace & Company, New York, 1940, p. 224.

Conclusion. Since Pasteur's proof that microbes can cause disease, discoveries and applications of the principles of germ control and immunization of individuals has practically wiped out certain diseases and drastically reduced illness and death from others. You are a link in the great human chain of defense against disease. As such it behooves you to: (1) keep your vitality and resistance high at all times; (2) be immunized against certain diseases, especially if an epidemic of them is threatened; (3) protect others as well as yourself by staying home if you are ill and by calling a doctor if anything serious is suspected; (4) practice at all times those habits of sanitation and cleanliness which reduce the chances of infection to yourself and others; and (5) as a citizen do all possible toward passing health laws and regulations and help see that they are carried out.

ACTIVITIES

1. **Self-check on your study of this problem.** See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. **Growing bacteria.** Prepare culture plates by boiling together for 15 minutes:

10 grams agar agar
1,000 grams water
10 grams beef extract
10 grams peptone
10 grams salt
a pinch of baking soda — enough until solution barely turns red litmus blue

Pour immediately into small Petri dishes which have been thoroughly sterilized by boiling 20 minutes (or by steaming in an autoclave — pressure cooker). Cool.

Expose each plate for a moment to one object such as dust-filled air, water, or a finger nail. Then keep it in a dark place at about body temperature for two or three days. Each bacterium which landed on the plate will multiply until it forms a *colony* of thousands of bacteria, all of which together will be visible as one tiny speck. The number of colonies will give you an idea of the number of bacteria in your sample.

3. Reports. This problem offers to you most interesting possibilities for reference reading and reports. Here are a few suggested topics:

a. Major Walter Reed and the conquest of yellow fever, and how this made possible the building of the Panama Canal.

b. Robert Koch, "The Death Fighter," (and many other such topics. See Table of Contents of books like *Microbe Hunters*, *Men Against Death*, and *Who's Who Among the Microbes*. See references at end of this problem).

c. The health department in your city or county — what it does and how it operates. (This may include a field trip to laboratories and clinics of this department.)

d. Write to United States Public Health Service, Washington, D.C., for the pamphlet on "The Control of Communicable Diseases, Vol. 50, No. 32, Aug. 9, 1935." It would be well to have this valuable pamphlet in your home for handy reference in case of illness.

Your Health Habits

Check yourself on the following habits. Do you —

a. Always wash your hands after using the toilet and before eating (including before lunch at school)?
b. Always cough or sneeze into a handkerchief?
c. Avoid carrying or handling soiled handkerchiefs?
d. Burn or boil handkerchiefs used during a cold?
e. Avoid spreading germs by expectorating?
f. Avoid going barefoot in places that might have been contaminated with "athlete's foot" or hookworm?
g. Avoid unnecessary direct or indirect contact with persons ill with infectious diseases?
h. Call a doctor at first symptoms of an infectious disease?
i. Take proper immunization steps, especially if an epidemic is threatened?
j. Stay away from others when you have a cold or other infectious disease?
k. Abide by health regulations and try to help others to do so?
l. Report to health authorities any dangerous violations of health laws you may observe?

4. Key Words. Add these to the list in your notebook and write briefly your ideas (*not* merely a definition) about each:

microbe
germ
disinfection
immune
immunization
antibody
vaccine
serum
public health

5. Two debates. Resolved: That the United States government should establish a Department of Health headed by a Secretary of Health in the President's cabinet. (References below, and in footnote, page 434.)

Resolved: That the State of ——— (your state) should adopt a system of socialized medicine. (References below.)

SUGGESTED REFERENCES[1]

*Communicable Disease Control: White House Conference on Child Health and Protection,** The Century Company, New York, 1931.

Crisp, K. B., *Be Healthy*, J. B. Lippincott, Philadelphia, 1938, 300–83.

Davis, Michael M., *America Organizes Medicine,** Harper & Brothers, New York, 1941.

De Kruif, Paul, *Microbe Hunters*, Harcourt, Brace & Co., New York, 1926.

—— *Men Against Death*, Harcourt, Brace & Co., New York, 1932.

—— *The Fight for Life*, Harcourt, Brace & Co., New York, 1938.

Delano, Jane A., *Home Hygiene and Care of the Sick*, P. Blakiston's Son, Philadelphia, 1933.

Fishbein, Morris, and others, *Modern Home Medical Adviser*, Doubleday, Doran & Co., New York, 1936.

Geiger, J. C., *Health Officers' Manual, General Information Regarding the Administrative and Technical Problems of the Health Officer*, W. B. Saunders Co., Philadelphia, 1939.

Hilliard, Curtis M., *The Prevention of Disease in the Community*, McGraw-Hill Book Co., New York, 1931.

Newcomer, Marion S., *Bewildered Patient*, Hale, Cushman, & Flint, Boston, 1936.

Park, William H., *Who's Who Among the Microbes*, D. Appleton-Century Co., New York, 1936.

Thone, Frank, *The Microscopic World*, Julian Wessner, New York, 1940.

University Debaters' Annual, 1935 and 1936, H. W. Wilson, New York. (For material concerning socialized medicine.)

Zinsser, Hans, *Rats, Lice and History*, Little, Brown & Co., Boston, 1935.

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[1] Use also books listed in *General References*, page 551, in footnotes, pages 424 and 434, and in Activity 3d, page 436.

* For teachers and advanced pupils.

Problem 24. *How Can Minor Injuries and Disorders Be Treated?*

Do unto others as though you were the others.
— COLEMAN COX

STUDY OUTLINE

A. Bandaging and transporting the injured
  1. What steps should be taken before applying first-aid bandages?
  2. In what ways can elastic bandages and adhesive tape be used as strapping?
  3. Under what circumstances would you use hot or cold applications?
  4. What special precautions should be observed in transporting patients from the scene of an accident?

B. The treatment of wounds and general injuries
  1. How would you stop severe hemorrhage (bleeding)?
  2. What precautions would you use in treating open skin wounds?
  3. What first-aid treatment would you give for a severe burn?
  4. For what various purposes and exactly how would you give artificial respiration?
  5. What are the essential steps in treating poisonous snake bite?
  6. When would you use splints, and what precautions should be observed?
  7. In cases of poisoning, what steps should be followed?

C. What to do for unconscious patients
  1. What is the difference in nature and treatment between shock and fainting?
  2. How would you distinguish between apoplexy, brain injury, and intoxication?
  3. How does treatment for sunstroke differ from that for heat exhaustion?
  4. What first aid can you give in a case of epilepsy?
  5. How would you go about treating cases of (a) opium and (b) gas poisoning?
  6. How can you safely rescue a victim of electric shock who is in contact with a live wire?

D. The first-aid kit
  1. What should the home first-aid cabinet contain?
  2. What type of kit is suitable for outing and automobile trips?

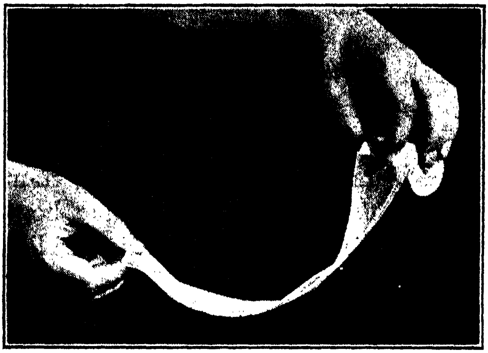
TO GIVE, or not to give, first aid! That is the question that each of us faces sooner or later. Without doubt, many persons have suffered serious injury, or possibly life-long disability because some well-intentioned and enthusiastic first aider used the wrong technique. It is better not to use first-aid procedures unless you are well informed on what is safe and unsafe. It is just as important to know what *not* to do as what *to do.* The right technique, however, applied at the right time, often results in the saving of a life, or the preventing of more serious injuries.

It is the purpose of this section to point out what techniques can safely be used by the first aider, and to indicate some of the things that can be done to make the patient more comfortable until the doctor arrives. The Red Cross *First Aid Text-book* lists all of the things that can be done justifiably by the first aider. You should have a copy of this book in your library at home and one in your automobile first-aid kit. In severe injuries, the first thing is to call a physician, and then until his arrival administer such simple first-aid treatment as may save life or avoid complications. This may include, in some cases, moving the patient, putting on temporary splints or bandages, stopping hemorrhage, restoring consciousness, or applying artificial respiration.

BANDAGING AND TRANSPORTING THE INJURED

Many accident victims require some form of bandaging to protect them from excess bleeding and infection; in some cases it is essential to transport them from the scene of the accident to a place where they may secure adequate care. A great deal of damage may be done unless treatment is properly administered. In severe cases attempt to make the patient safe and comfortable on the spot until the arrival of the physician. Do not attempt to move him unless unusual circumstances make shifting him absolutely necessary.

Use of roller and triangular bandages. The gauze roller bandage (Fig. 160) in varying widths from ½ to 3 or more inches is very useful. The 1- and 2-inch rollers are used most extensively. The gauze bandage is sterile as it comes from the package, and if not handled with the fingers can be placed directly in contact with an open

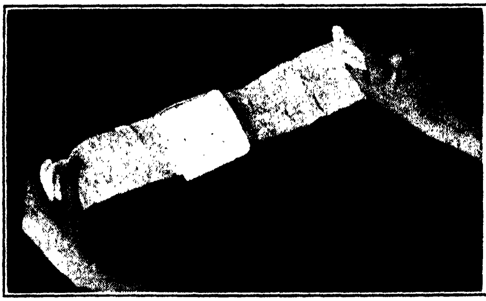


160 Roller gauze bandage. The gauze may be doubled back on itself several times to make a compress (pad). Be careful not to touch the surface of the compress with the fingers. It can be held in place with adhesive tape or with a roller bandage. (Courtesy of American Red Cross)

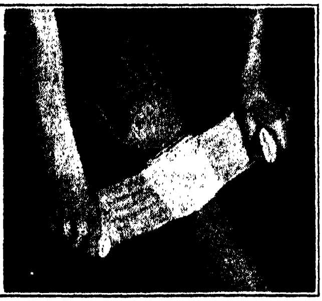
wound. Layers of gauze roller bandage can be used as compresses to stop bleeding. The roller can also be used to hold compresses in place (Figs. 161 and 162). It can even be used in several ways as a supporting sling for injured arms and hands. The Red Cross *First Aid Text-book* gives detailed descriptions of the various types of bandages applied to the several parts of the body.

The triangular bandage is a simple and quickly applied first-aid device (Fig. 163). It is the one commonly used for supporting slings, but may also be folded in narrow cravat form and used to hold wound compresses in place. It is also effective as a strapping device for sprained ankles. A triangular bandage should be in every first-aid kit.

The use of strapping devices. The first aider can safely use the cravat bandage for strapping the usual sprained joint. The



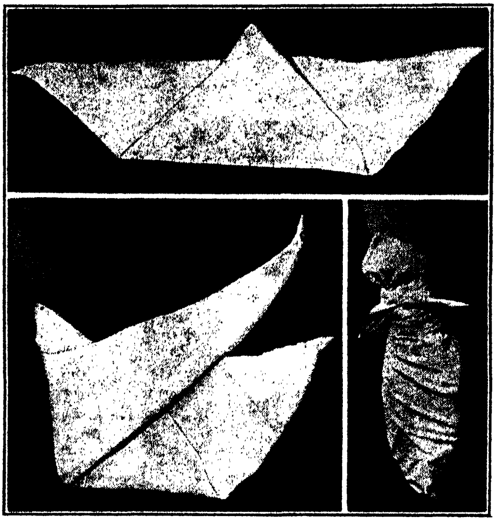
161 A bandage compress looks like this. It is made of several thicknesses of sterile gauze placed in the middle of a strip of gauze or muslin. Small compresses (Band-Aids), for minor cuts, consist of gauze pads attached to strips of adhesive tape ($\frac{1}{2}$ to 1 inch wide, and 2 to 3 inches long). (Courtesy of American Red Cross)



162 A bandage compress being applied. Be careful not to touch the surface of the compress. Remember never to put adhesive tape of any kind directly on a wound. (Courtesy of American Red Cross)

strapping gives support in place of the ligaments that have been damaged. Roller elastic bandages are also suitable for this purpose.

Applying heat and cold. Heat can be applied to good advantage in the form of hot-water bottles or bags, salt packs, hot towels, and hot baths. It is useful to relieve local pain; to reduce swelling from sprains, strains, or bruises; to relax cramped or fatigued muscles; and in some cases to act as a stimulant. Care should be used never to apply hot-water bottles or electric pads to unconscious persons, since they are helpless to detect or call attention to too great heat. Many serious burns result in this manner.

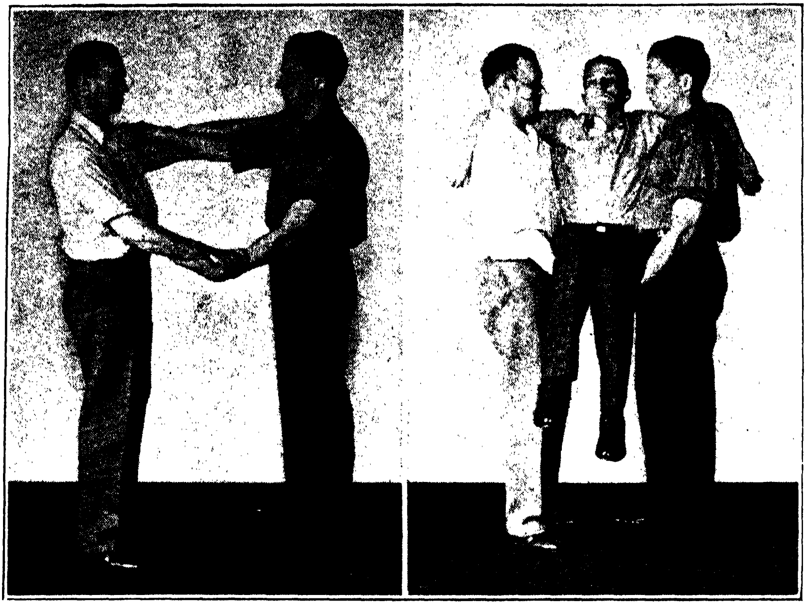


163 The open hand bandage illustrates the use of the triangular. Place the hand, palm down, on the exact center of a triangular bandage. Pull the tip of the triangle back so that it covers the wrist well (*top*). Next wrap each half of the bandage back toward the wrist keeping it parallel to the hand (*left*). Wrap the ends around the wrist and tie (*right*). (Courtesy of American Red Cross)

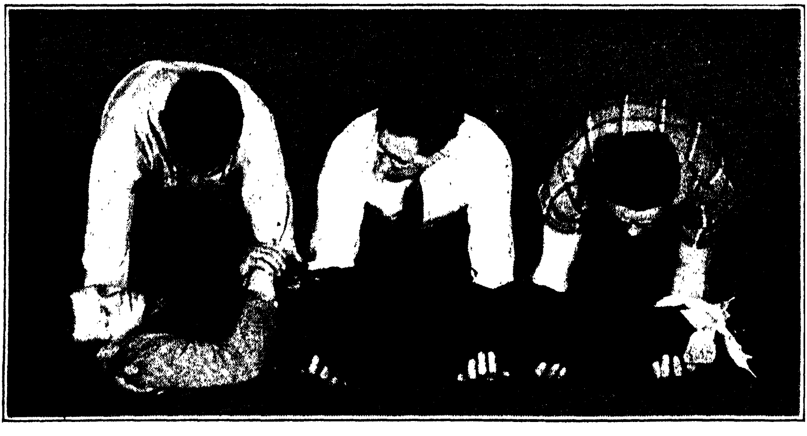
Other stimulants are used to supplement heat in cases of fainting, shock, and drowning. These include hot coffee, or other hot drinks, and aromatic spirits of ammonia.

Cold is applied by towels wrung out of cold water or ice water, or by ice packs. Cold is used chiefly to reduce temperature, to prevent swelling in bruises and similar injuries (by contracting blood vessels), and in some cases to stimulate breathing.

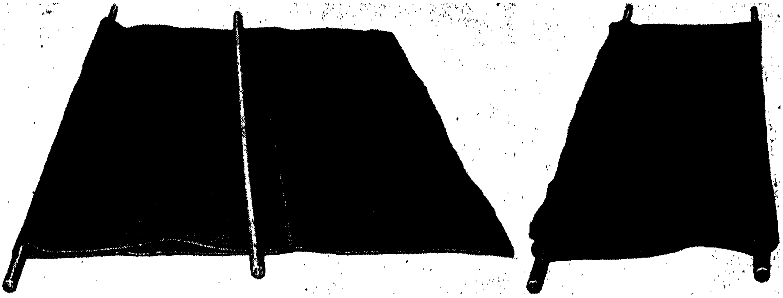
Transporting patients from scene of accident. If possible, patients should be kept at the scene of the accident until the doctor's arrival so as to avoid more severe injury in transporting them. Such precaution is particularly needed where they are unconscious or otherwise unable to indicate the location of severe pain. Many simple fractures are compounded (that is, a bone protruded through the skin) by carelessness in moving the patient. The safe procedure



164 The two-man carry can be used for some cases. The bearers each place one arm underneath the patient's thighs and the other around his back, just under the armpits (*right*). Note position of hands on wrists and shoulders (*left*). The patient places his arms around the necks of the bearers. (Courtesy of American Red Cross)



165 The three-man carry is used for serious cases. If one side is injured, the bearers should take position on the uninjured side, with one man at the shoulder, one at the hips, and the third at the knees. The bearers rise to their knees; the patient is rested on the knees; they then rise to standing position, or place the patient on a stretcher. (Courtesy of American Red Cross)



166 Improvising a stretcher from blanket and poles. Note that the first pole is placed on the blanket, and the end then folded back, and the second pole placed on top (*left*). The blanket is folded over the second pole (*right*) and pinned securely. (Courtesy of American Red Cross)

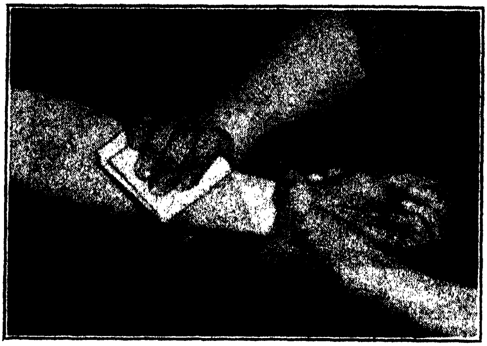
is to call for medical help, and make the patient comfortable on the spot until the arrival of the physician. If necessary to transport, great care should be used, with a minimum of handling (Figs. 164 and 165). Emergency stretchers should be prepared if possible (Fig. 166). Detailed instruction on such techniques will be found in the Red Cross *First Aid Text-book.*

Probably the largest number of accidents with which you will have to deal outside of the home are those occurring in connection with automobile traffic. The first step in such cases is to have someone notify a doctor or first-aid station and the police department or highway patrol, giving exact location of accident and nature of injuries.

Every car should carry a first-aid kit, a flashlight, and a blanket for use in emergencies. In most communities at the present time, highway first-aid stations will be found at frequent intervals, with trained technicians on duty.

TREATMENT OF WOUNDS AND GENERAL INJURIES

At home, at school, in industry, or on the highway you have frequent occasion to care for various types of accidental injuries for which medical care is not immediately available. It is, accordingly, important that you know what to do for the more common accidental injuries.



167 Bleeding may sometimes be stopped by direct pressure. Be certain you allow no dirty material to come in contact with the open wound. If it is available, use sterile gauze. (Courtesy of American Red Cross)

How to care for hemorrhage and skin wounds. Have you ever seen a severe injury with excessive bleeding? If so, you will appreciate the problem of checking severe hemorrhage. In slight superficial wounds, a small amount of bleeding is beneficial as it cleanses the area and tends to wash out germs that might have been introduced. Severe bleeding, however, must be stopped immediately, else it may result in death.

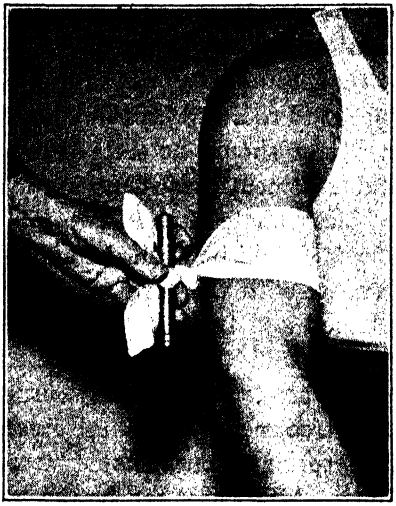
If the blood is bright red in color and is flowing in spurts, it will indicate that an *artery* has been cut. In such case pressure should be applied either directly on the wound or preferably on the artery itself near the wound and on the side where it comes from the heart. A folded sterile gauze compress, or even a clean handkerchief can be used to put pressure on the wound itself (Fig. 167). Pressure points for arterial bleeding are described in the Red Cross *First Aid Text-book.*

If the flow of blood is too strong to be stopped by finger pressure, a tight bandage may be applied directly over the compress, or a tourniquet (to͞or′nĭ-kĕt) can be tied around the arm about halfway between the elbow and shoulder, or around the thigh just below the groin. A tourniquet can be made of a triangular bandage, a large handkerchief, several layers of roller bandage, or even a necktie (Fig. 168). A stick can be used to twist it tight. It is very important to remember that a tourniquet should be loosened for a moment or two every 20 minutes in order to supply blood to the extremity. Otherwise gangrene may set in.

When a *vein* is cut, the blood is of a darker red, and flows slowly and steadily without spurting. Usually it can be controlled by firm pressure with a bandage directly over the wound, or if necessary by pressure on the vein at the side of the wound farthest from the heart.

Capillary bleeding, the kind found in most minor wounds, can usually be checked easily with a bandage placed directly over the wound. Very cold or very hot water will help check such bleeding. If the bleeding persists, pressure on the artery above the wound for a moment will help.

In the case of *nose bleed*, firm pressure against the upper lip just under the nose will usually serve as a check. If necessary, small cotton packs can be inserted within each nostril. A cold pack on the back of the neck also helps.



168 The tourniquet is a dangerous instrument. It should be used with great caution, and only when absolutely necessary, to stop bleeding. May be used with a pressure pad over the artery, or merely as a constricting band. Must be tight enough to cut off flow of blood in artery. (Acme)

After bleeding has been stopped, the next most important step in handling a wound is to *avoid possible infection*. Even in very small wounds infection may occur. If *boiled* water and pure soap are available, it may be desirable to wash the wound, particularly if it is dirty. Otherwise, just apply mild tincture of iodine or other antiseptic. When thoroughly dry, cover with a sterilized gauze-bandage compress and bind it in place with roller bandage or adhesive tape. Never use absorbent cotton or adhesive tape as a compress directly over a wound. If sterile gauze bandages are not available, a piece of clean cloth can be sterilized by running a hot iron over it for several minutes.

Punctured wounds caused by rusty nails, splinters, and other sharp objects are particularly dangerous because they are difficult to clean properly, often do not bleed well, and may possibly contain tetanus germs. Such wounds should be treated immediately by a physician, even though they may seem minor. Even slight wounds should be treated by a physician if they develop much pus, are accompanied by any fever, or begin to show red streaks extending from the wound toward the heart. The latter indicate serious infection which might develop into blood poisoning.

The treatment of burns and sunburn. Minor burns can be treated by the application of tannic acid jelly or a solution of bicarbonate of soda. In case of blistered areas great care should be observed to avoid breaking any of them. In severe burns or scalds a doctor should be secured immediately. In the meantime, first-aid treatment consists normally of immersing the part in a solution of bicarbonate of soda, two tablespoons to a quart of water. Acid burns should be washed thoroughly first with clean water, and then treated with the soda solution. Alkali burns should similarly be washed and treated with a weak vinegar solution. Carbolic acid burns should be treated with alcohol, which neutralizes the effect of the acid. All chemical burns should be referred to a doctor for final treatment. *Never* use greasy salves in treating severe burns.

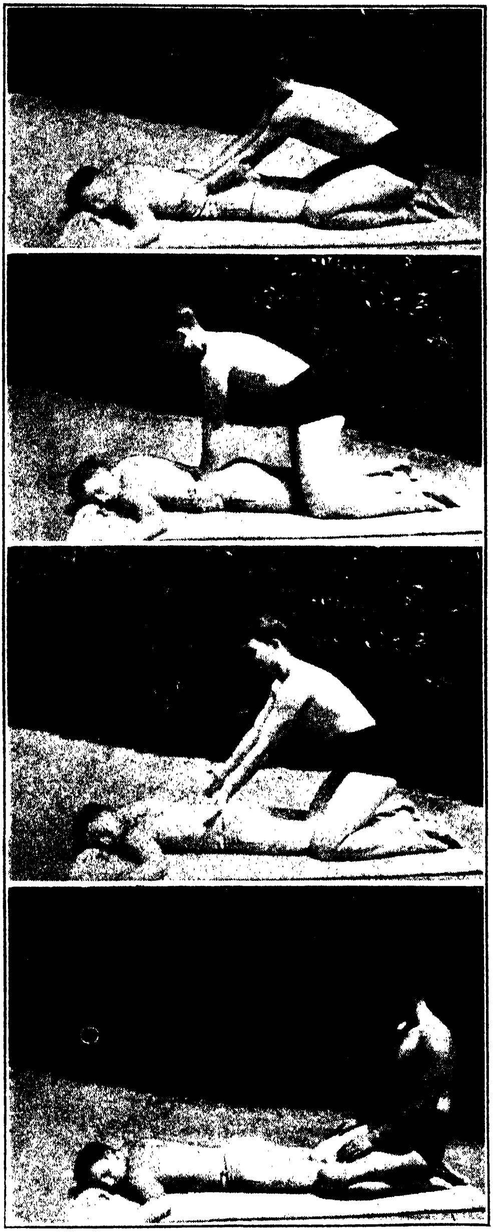
Cases of sunburn should be treated locally, the same as a regular burn. Mild cases can be relieved by applications of olive oil, cold cream, or any of the many lotions and creams available on the market. The best way to treat sunburn is to *prevent* it by avoiding excessive exposure until the skin has become accustomed to the sun. Severe burns should be treated by a physician. If too large an area is affected, death may result.

Artificial respiration. In case of drowning, gas poisoning, electric shock, or other form of asphyxiation it is desirable to secure the services of a police or fire emergency squad with a mechanical inhalator. Where this is not available, however, or until it arrives on the scene, the Schäfer method of artificial respiration, now commonly known as Standard Technique, should be used. Every second counts, hence respiration should be started immediately without attempting to loosen clothing.

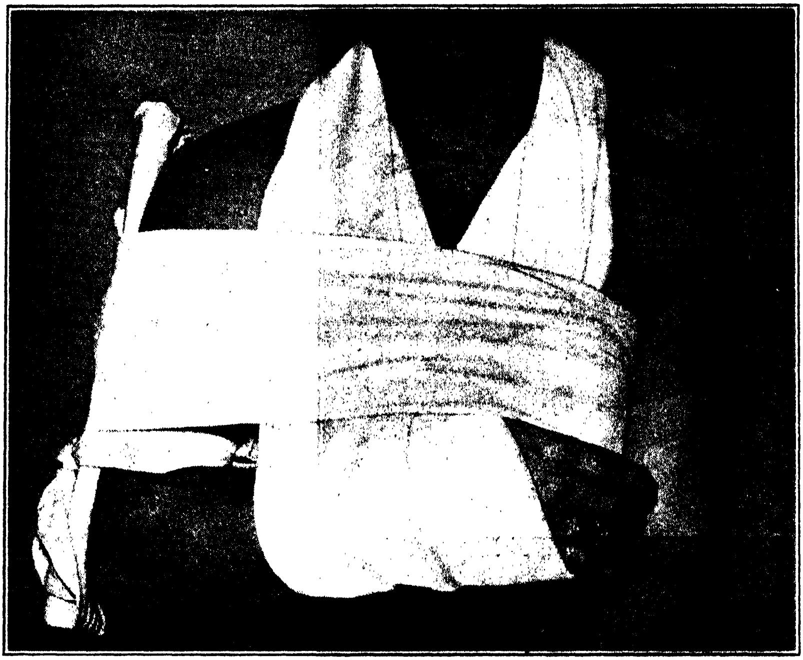
Place the patient face downward, head turned to one side and resting upon one arm, with the other arm extended over head. Kneel straddling one or both of the patient's thighs; place the hands on the lower ribs with the arms straight (Fig. 169A); lean forward, applying pressure lightly for two seconds (Fig. 169B); then swing backward to a sitting position on the heels, removing the hands from the patient's back (Fig. 169C–D). Hold this position for two seconds, then swing forward and again apply pressure. Continue this alternating pressure and release about 12 to 15 times per minute for a period of 4 or 5 hours unless the patient recovers or a doctor pronounces him dead. The patient should be kept warm with blankets or other covering, and hot-water bottles or other heating appliances if available.

Aromatic spirits of ammonia on a handkerchief held to the patient's nose will serve as a stimulant while he is still unconscious. When he returns to consciousness and normal breathing, give him a teaspoonful of aromatic spirits of ammonia in a glass of water, followed by hot coffee or tea, or clear hot water.

The care of snake and animal bites. In case of a bite by a poisonous snake (rattlesnake, copperhead, or water moccasin) first apply a tight bandage immediately above the bite so as to cut off the flow of blood back to the heart. This is to prevent the poison from being distributed throughout the system. As in the use of a tourniquet, it should



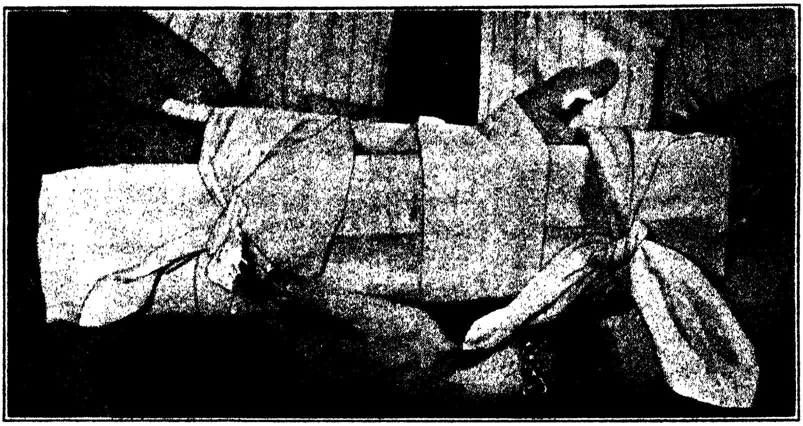
169 The Schäfer (standard) method of artificial respiration. This method is now generally used for cases of drowning, suffocation, drug poisoning, etc. The alternating pressure and release must be maintained in continuous, regular rhythm.



170 Any material used for a splint should be stiff enough to prevent further movement or injury to the fracture. (Acme)

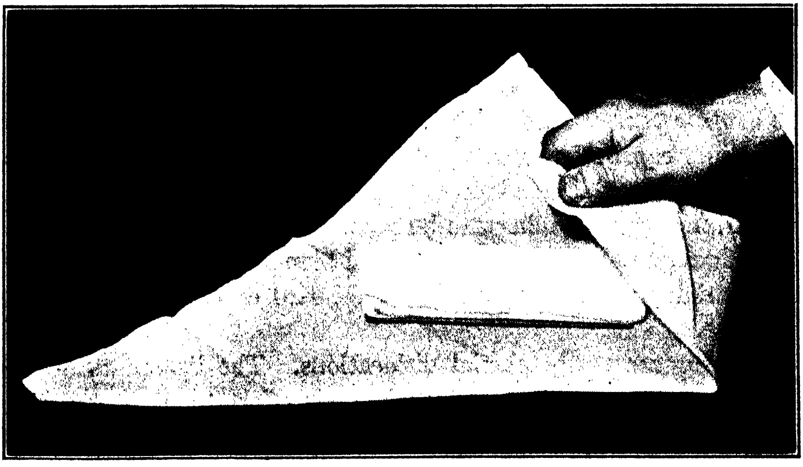
be loosened for a moment or two every 20 minutes. If alcohol or iodine is available, sterilize the wound and the surrounding skin, then, with a sharp knife, or some similar instrument which itself has been sterilized by holding in a flame, make two or three cuts across each fang hole a little over $\frac{1}{8}$ inch deep to encourage free bleeding. Be sure not to cut a large artery or vein. If a snake-bite suction cup is available, use it; otherwise suck the wound with the mouth, spitting out the poisoned blood. Be sure not to swallow any saliva which may contain minute amounts of the poison. Treat the patient for shock with heat and stimulating drinks or aromatic spirits of ammonia, and get him to a doctor immediately. Do not let the patient walk.

Dog, cat, and other animal bites should be treated much the same as other wounds, except that there is always the possibility of rabies. A doctor should be consulted as soon as possible. He will determine the type of treatment. Have the dog examined at once.

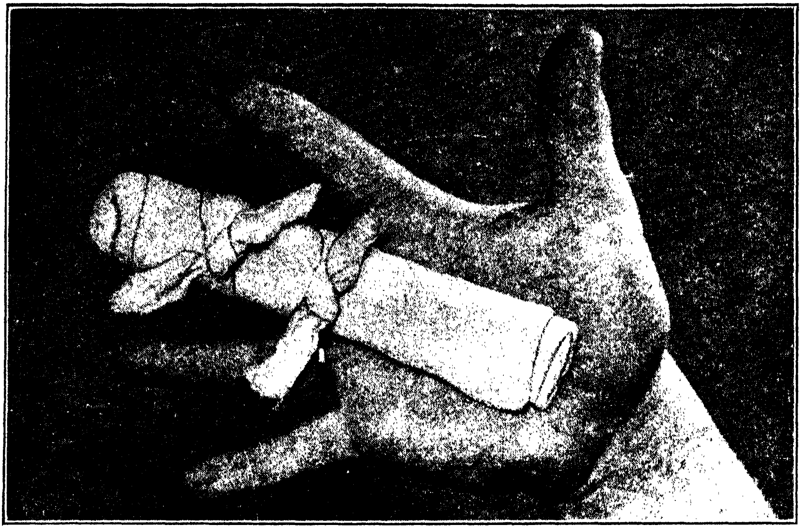


171 A triangular cravat bandage is used to fasten this splint in position. A triangular bandage sling should be used to support it (see Fig. 170). (Acme)

Treating fractures, sprains, dislocations, and bruises. *Fractures* (broken bones) should be treated by a physician at the spot where the injury occurred, if possible. If the patient must be moved, great care should be observed not to make the fracture worse. The fracture should be splinted temporarily until a doctor can be reached. Splints can be made of any fairly stiff material such as old newspapers, magazines, cardboard, or thin boards (Fig. 171).



172 Padding a splint. Padding should be thick and soft enough to allow for extensive swelling, without interfering with circulation. (Acme)



173 It is sometimes advisable to splint a badly sprained finger, to prevent unnecessary movement. (Acme)

Use splint wider than the part splinted and extend it beyond the extremity. It should be thoroughly padded with clothing, cotton padding, towels, or other soft material to avoid discomfort and the possibility of cutting off circulation (Fig. 172).

In a *compound fracture* (usually caused by end of bone puncturing skin), the wound should be bandaged first, using great care to prevent infection. If splints must be applied, use exceptional care to avoid any further damage by manipulation. *No attempt should be made to push the ends of the bones into the flesh.*

Splints can be fastened in place by the use of adhesive tape or roller or triangular bandages. If a helpless patient must be transported, a crude stretcher can be made by using a blanket rolled at the edges on poles (see Fig. 166), or a blanket alone with the edges rolled tightly will do. Even a wide board or door will serve the purpose.

Sprains are really partial dislocations. The ligaments around the joints are stretched or torn in their effort to prevent a bone from becoming dislocated. They can be very painful, and often prove serious, with perhaps more lasting damage than that of a fracture. First-aid treatment consists of elevating the part and applying cold compresses to prevent swelling. If the joint must be used immediately, bind firmly with cravat bandage to give artificial support to the ligaments (Fig. 173). General treatment of sprains usually consists of complete rest for a few days, combined with cold applications and later, gentle massage and firm bandaging before actual use.

In case of a *dislocation*, a doctor should be called immediately. No attempt should be made to reduce it as this may result in serious damage to tissues, nerves, blood vessels, or the bone itself. Cold applications to the spot affected will help prevent swelling and relieve pain. If shock is present, treat the patient with stimulants and heat to the body — *not* to the dislocated joint.

Bruises are best treated immediately with cold applications to prevent swelling, discoloration, and pain.

Strenuous activity often results in *muscle cramps*. These can be relieved by hot applications and massage. Stiff neck can be treated in much the same manner. So-called "shin splint" often occurs among athletes, particularly early in the season. This should be treated by rest and hot applications.

The treatment of poisoning. Internal poison is often indicated when someone is taken suddenly ill without apparent cause. The immediate first-aid procedure is to empty the stomach of poison by the use of an emetic (i.e., vomit-inducing agent) such as a teaspoonful of mustard, salt, or one tablespoonful of bicarbonate of soda, in a glass of lukewarm water. If the poison is an acid, an antidote should be given before using the emetic — either milk of magnesia, or bicarbonate of soda and water. In case of strong alkali poisons, such as lye or ammonia, give antidote first, such as vinegar, lemon or orange juice. Then give the emetic. After the stomach is empty, give the patient large quantities of liquid and an antidote, then — after one half hour — soothe the stomach membranes by giving milk, raw eggs, or vegetable oil. Also give a stimulant to the patient.

WHAT TO DO FOR UNCONSCIOUS PATIENTS

The unconscious patient is helpless. He cannot give you any information as to his condition, hence you must determine what is wrong with him by the general symptoms and circumstances.

First, you should examine for bleeding, poisoning, apoplexy, asphyxiation, and sunstroke. Each of these requires immediate treatment of a specific type if the patient's life is to be saved. If unconsciousness lasts more than a few minutes, a physician should be summoned immediately.

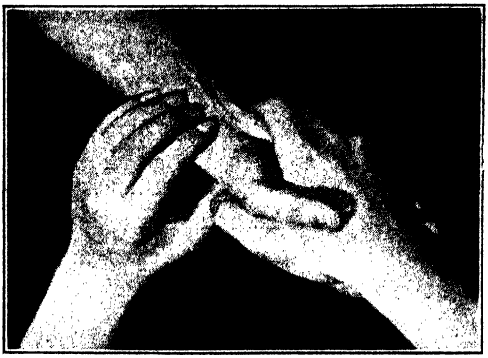
Shock and fainting. Severe pain, extreme nervous upset, or excessive loss of blood result in what is known as *shock.* This may produce merely a dazed condition, or in serious cases complete unconsciousness. The face is usually pale and pinched in appearance, with dilated eye pupils. Breathing will be feeble. Keep the patient as quiet as possible, lying down with the head low. Use blankets, hot-water bags at his feet, or other means of warming. If you are sure there is no head injury, stimulants may be given. If the patient is unconscious, hold a handkerchief soaked with aromatic spirits of ammonia to his nose. If he is conscious, hot coffee or tea, or a half teaspoonful of aromatic spirits of ammonia in a half glass of water may be given.

Fainting may be due to weakness following an illness, excess fatigue, lack of food, sudden shock, or even fear. The face is pale, breathing shallow, and pupils normal. The patient should be kept lying down with the head low and the clothing open, and, if possible, in the fresh air. Smelling salts or aromatic spirits of ammonia held to the nose for a moment will serve as a stimulant. Cold water dashed on the face is helpful. Deep, steady pressure on the abdomen will tend to force blood from the large vessels back to the head.

Apoplexy and brain injury. Apoplexy is caused by the rupture of a small blood vessel in the brain, resulting in pressure by the escaping blood on certain areas, and causing partial or complete paralysis. Symptoms are similar to other forms of brain injury. The face is flushed, the pupils unequal, one side partly paralyzed, breathing heavy, and the pulse is slow and full (Fig. 174). The patient should be kept very quiet and should not be moved. The head should be slightly and carefully raised (just the reverse of fainting or shock). The feet should be kept warm and the head cool. Do not use stimulants. A physician should be called immediately.

Apoplexy is often confused with intoxication. Both conditions may be present at the same time. In intoxication, however, the pupils are normal and equal in size, and the pulse is usually fast instead of slow.

Sunstroke and heat exhaustion. These two conditions are similar but require radically different treatment. Both call for immediate care by a physician. *Sunstroke* victims have a high fever and a flushed face, the pupils of the eye are usually dilated, the skin dry and hot, and the pulse rapid. Place the patient in a cool spot and apply ice packs, or repeatedly dash cold water over his body and head to reduce temperature. Care should be observed not to cool him too rapidly. Do not give stimulants.



174 Taking pulse. Note that the pulse can be located at the wrist near the thumb side (the radial artery.) The fingers should be placed lightly on the wrist. Do not press hard, and do not use the thumb. The average pulse rate for a man is about 72; for women and children about 80. (Courtesy of American Red Cross)

The victim of *heat exhaustion* will be dizzy and nauseated, face pale, skin clammy, and pulse slow. He should lie down in a cool spot, with clothing loosened, and be given stimulants. Also give warm water to drink with table salt added, about one teaspoonful to a glass. Stimulants may be given in the form of hot drinks.

Epilepsy. Symptoms include twitching and convulsive movements of the muscles, with frothing at the mouth, irregular breathing, and pale face. The patient should be kept in an open space with a pillow under the head to avoid injuring himself. A handkerchief or other object placed between the teeth will prevent biting the tongue. Call a physician.

Opium and gas poisoning. *Opium* poisoning is characterized by very fine pupils the size of a pinhead. The patient should be given an immediate emetic, then stimulated vigorously and kept awake. This may require walking him up and down constantly.

In *gas* poisoning the patient's lips are blue, skin pinkish pale, breathing intermittent, pulse weak. The patient should be given fresh air, stimulants, and artificial respiration. If possible an inhalator crew should be called, as well as a physician.

Electric shock. If a victim of electric shock is still in contact with the wire, do not touch him or the wire, or you also may be electrocuted. Push the wire well out of the way with a dry, wooden stick. Then treat the patient. He will have a weak pulse, shallow breathing, and sometimes burns about the body. He should have immediate vigorous artificial respiration, if possible with an inhalator crew. The Schäfer method can be used until the other is available. He should be kept warm and given stimulants as soon as he can take them.

FIRST-AID KIT

The home first-aid cabinet. The American Red Cross recommends the following items for the home first-aid cabinet: Individual packages of 1-inch compress on adhesive tape (band-aids); individual packages of 3-inch sterile gauze squares; individual packages of assorted sterile bandage compresses; sterile absorbent cotton; triangular bandages; individual packages of 36-inch sterile gauze squares; picric acid gauze; 5 per cent tannic acid jelly for burns; mild iodine; inelastic tourniquet; scissors and forceps; paper cups; 1- and 2-inch roller bandages; 1½-inch roll of adhesive tape; wire or thin-board splints; sterile castor oil or mineral oil for use in eyes; and aromatic spirits of ammonia.

The automobile and outing kit. A simple first-aid kit for carrying in the automobile or on camping and hiking trips is as follows: one half dozen 1-inch band-aid bandages; 2- and 3-inch sterile gauze bandages; one or two triangular bandages; roll of 1½-inch adhesive tape; small package sterile absorbent cotton; half dozen ampoules of aromatic spirits of ammonia; half dozen iodine ampoules; one tube tannic acid burn ointment.

Conclusion. The instructions given in this problem have not been for the purpose of training you to take extensive care of injuries and disorders. First-aid treatment should be just what the name implies; namely, to protect the patient from extreme discomfort and more serious injury until medical treatment can be secured. Do not attempt to do anything in the way of first aid that is not approved in the Red Cross *First Aid Text-book.* It is possible that you may even face legal difficulties if you do.

If you will familiarize yourself thoroughly with the materials presented herewith you should be able to take care of the most common emergencies. Supplement this material with a thorough study of the Red Cross *First Aid Text-book*.

ACTIVITIES

1. **Self-check on your study of this problem.** See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. **Accident reports.** Bring to class lists of nonfatal accidents cut from daily papers and discuss proper procedures in rendering first aid in each case.

3. **Hospital visits.** If possible, visit the city or police hospital to observe the handling of various types of emergency cases as they come in, and to talk over with hospital officials the most common types of accidents they are called upon to handle. A committee of the class might be appointed to make such a visit and report on it.

Your First Aid Habits

Check yourself on the following habits. Do you —

a. Always call a physician immediately in case of severe injury?
b. Check serious bleeding as first step?
c. Limit your first aid strictly to procedures approved by the American Red Cross *First Aid Text-book?*
d. Treat serious cases on the spot to avoid transportation hazards?
e. Splint fracture cases carefully before transporting them?
f. Avoid touching surface of bandage compresses with the fingers?
g. Use tourniquet only in extreme necessity?
h. Start artificial respiration *immediately* when needed?
i. Use care not to burn unconscious patients with heating appliances?
j. Avoid use of greasy salves on severe burns?
k. Carry a first-aid kit, flashlight, and blanket in your car at all times?

4. Artificial respiration. Request the local representative of the American Red Cross to come to class and give a demonstration of the Schäfer method of artificial respiration. It may be possible also to get the fire department inhalator squad to demonstrate the use of their apparatus.

5. Practice in bandaging. Arrange to have each member of your class bring a triangular bandage and a 1- or 2-inch roller bandage for practice purposes. Each of you may then practice on other members of the class, trying out the various bandages illustrated in this problem and in the Red Cross *First Aid Text-book.*

6. Transporting devices. Practice making emergency stretchers with blankets and poles or boards. Practice also on the preparation of emergency splints of various sizes and types from such materials as magazines, newspapers, wire netting, apple-box boards, and umbrellas.

7. Stopping bleeding. Study the pressure points for bleeding as described in the Red Cross *First Aid Text-book.* Practice in class on other students until you are able to locate these pressure points and can actually compress the arteries as required to check bleeding.

SUGGESTED REFERENCES

American Red Cross, *First Aid Text-book,* P. Blakiston's Son, Philadelphia, 1937.

American Red Cross, *Red Cross Life Saving Methods,* The Red Cross, Washington, 1937.

Boy Scouts of America, *First Aid,* Boy Scouts of America, New York, 1930.

National Safety Council, *First Aid Reminders,* The Council, Chicago.

U.S. Treasury Department, Public Health Service, *What to Do in Case of Accidents,* The Department, Washington, 1928.

Unit X. *Planning a Safe Society*

YOUTH frequently is disturbed over what it considers undue adult concern regarding safety precautions. Perhaps even you feel that way occasionally because dad warns you to drive carefully, or insists that you do not attempt to see how fast the car will go. As a matter of fact, however, statistics show a sad story of accidental death and injury resulting from carelessness or thoughtlessness. Hence parents, teachers, and other adults have good reason for being concerned.

Most adults do not desire to curtail the activities of youth. Yet they recognize that we live in a hazardous age with a large number of complicated and fast-moving machines. They believe that you must be trained to recognize these hazards and to develop techniques for protecting yourself. They want you to have adventure and thrills, but in reasonably safe form.

The fast-moving age in which we live can still be made reasonably safe provided you and every other boy and girl will learn how to contribute to safety. You, as a member of society, can damage not only yourself but also many others if you do not develop those practices which are for the good of the largest number.

The purpose of this unit is to point out ways and means whereby you as an individual may learn to handle yourself, your tools, instruments, and automobiles, more expertly and safely. If you have thought that safety practices are intended only for babies and weaklings, you have overlooked an important point. In all ages the men who have lived longest and most healthily have been those who practiced safety procedures. The foolhardy take chances. They die or are crippled early in life. The really brave men take intelligent steps to protect themselves and others. They become leaders.

Problem 25. *Do Safety Problems Really Concern You?*

It is better to be safe than sorry. — ANON

STUDY OUTLINE

A. The marvels of speed
  1. How can high-speed engines be made servants of man?
  2. Why do most fatal accidents occur at high speeds?
  3. What is the key to reducing the accident rate?

B. Our future world
  1. How will motor traffic be modified in the future?
  2. What traffic controls will our future world require?
  3. What social changes can we expect to see?

C. Danger versus safety
  1. Is it justifiable to take unnecessary chances?
  2. Is danger essential to a thrilling experience?
  3. What do hard-headed workmen think of safety practices?

D. The causes of accidents
  1. How are accidental deaths distributed as to causes?
  2. How many persons are killed and injured daily in America?
  3. What steps have been taken to reduce accidents?

A STREAM-LINED age calls for a stream-lined youth, not the reckless devil-may-care type of youth with no sense of responsibility and with a compelling urge to take chances and to see life in the raw; but rather the eager, enthusiastic, dependable youth who loves adventure, but knows his own limitations as well as his powers.

THE MARVELS OF SPEED

Doubtless you are frequently awed by the marvels of modern engineering (Fig. 176); the smooth, sleek, and powerful automobile that speeds along our modern highways; the many-motored airplane that streaks like a meteor across the skies; the beautiful stream-lined train that roars across the desert. The hundreds of horsepower represented in each of these machines places unbelievable power in the hands of the driver; but whether the machine becomes a horrible weapon of destruction or an efficient servant of the master mind depends upon the man at the controls.

175 The pole vaulter must have perfect balance, control, and co-ordination — *stream-lined action.*

The man at the wheel. The speeds of yesterday seem slow today. Doubtless, the speed of today will seem still slower tomorrow. Yet, the avoidance of accidents in speeding conveyances is dependent upon the quick thinking of the man at the wheel. The faster the speed, the greater will be the hazard, because the time for emergency thinking decreases as speed increases. Similarly, the amount of time and force required to stop the car going at a high speed is not merely twice as great as that required if it were going at half that speed. It is many times greater. Not only are accidents much more likely to occur at the greater speeds, but their severity increases proportionately.

It is thrilling to speed in a powerful automobile, but many people who today are in hospital beds or wheel chairs can testify that the moment's thrill which made them invalids for life was a very expensive adventure.

176 The sleek, swift stratoliner can carry you unbelievable distances in a short time. (Courtesy of TWA)

Keeping down the accident rate. The human brain is limited in reaction time and power of thought. Hence, as the complexity of machinery increases, the only hope of keeping down the rapidly rising accident rate lies in establishing more effective automatic controls, and in educating operators in the specific things to do, or not to do, in order to avoid accidents. Machinery can be improved indefinitely, but always the determining factor will be how the operator acts in emergencies.

OUR FUTURE WORLD

Perhaps you were one of the fortunate persons to attend the 1939–1940 World's Fair in New York City. If so, you must have seen the Futurama display, prepared by the General Motors Corporation. This exhibit, entitled, "Highways and Horizons" was an unbelievably elaborate portrayal of the world of the future. Its purpose was to impress people with the fact that the world of tomorrow can be made an infinitely better place in which to live.

Motor highways of the future. The Futurama demonstrated the congestion that might be expected by 1960, unless the nation's motor highways are greatly expanded and improved. By that time, motor traffic on many of the main highways, particularly in and about metropolitan areas, will increase, it is estimated, by as much as 100 per cent, with the number of motor cars reaching a total of 40 or 50 millions.

Improved express motor highways (Fig. 177) as visioned by the Futurama would contain one-way roads with as many as seven lanes accommodating traffic at various designated speeds; with traffic-control towers where experts would advise drivers, by radio control signals, how and when they might move safely from one traffic lane to another; and with carefully designed intersections that would eliminate all traffic conflicts and permit automobiles to move safely and easily without loss of speed into right- and left-hand turns.

Social demands of the future. Everything points to a future world in which you will be served by highly mechanized instruments and in which speed will be a dominant factor. If you will maintain a high level of efficiency, in terms of health, muscular co-ordination, and mental reaction, this new world into which you are plunging will offer you satisfying experiences of unlimited number and of infinite variety. You may enjoy these thrills for many years if you will *now* prepare yourself to participate skillfully in a wide variety of activities involving the use of machinery and extensive contacts with humans in social situations.

Wartime safety. World safety continues to be menaced by periodic wars. Modern warfare carries serious hazards not only for members of armed forces but also for the citizen in his home. This requires that every citizen, young or old, be instructed in how to protect himself and his property in case of air raids by enemy bombers. The problem of civilian defense in wartime has become a major concern of every community. (See Problem 31.)

DANGER VERSUS SAFETY

Safety education is not merely a protective fence for weaklings. It is not a set of rules for the avoidance of injury or death. It is not a regulation to force members of society to act safely whether or not they wish to do so. It is rather an approach to living whereby every man, woman, boy, and girl will wish to train himself so that he will become the most capable performer possible. He will wish to make his home, office, school, and highways safe, not because he

177 The highway of the future will contain many one-direction lanes with nonconflicting intersections to assure safety. (Courtesy of General Motors Corporation)

is afraid, but because he knows that everyone will live longer, more successfully, and more happily.

Taking unnecessary chances. No dynamic person wishes to be merely namby-pamby safe. On the other hand, he does not wish to take unnecessary chances. He wants to do things in a hearty American way, and if this involves danger, he is willing to face it. But will it not be much better if the unnecessary hazards can be eliminated? The spirit of modern safety education is not to force youth to participate in safe activities only, but rather *to make the important activities in which they do participate as safe as human thinking can devise* (Fig. 178).

Thrills without hazards. Some claim that if you take the danger out of an activity, it no longer has any thrill or challenge. Yet, does a driver pick the roads with rocks and holes and hairpin turns because the route is full of danger? Does the ship's captain pick the narrow, treacherous, rocky channel? Does a pilot select an

178 Having a doctor present at all athletic contests may help prevent serious results from accidents.

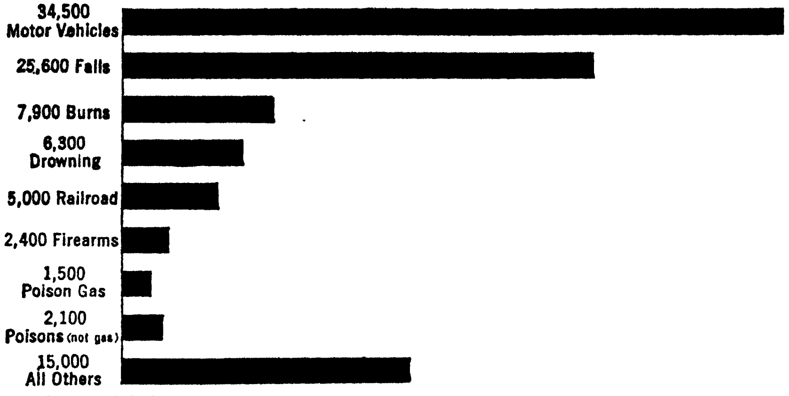
airplane that he knows has a faulty engine, or in which some of the wing stays are weak, or in which the landing gear is wobbly, because his trip will be more thrilling owing to the almost certain dangers involved? Or, does he prefer to have an engine that purrs in steady rhythm, with every strut and stay and wheel in perfect alignment, and as strong as engineers can make it?

Mechanics and safety education. If you would get the practical view of safety education, talk to the engineer who is constructing the immense suspension bridge, and let him tell you about the multitude of safety precautions he has to take for the protection of his men. Talk to the pilot who handles various kinds of airplanes. Observe the number of items which he must check continuously in order to protect himself and his passengers or cargo. Talk to the truck driver, who may appear hard-boiled and careless. You will find he is far more cautious than the average passenger-car driver. Truck drivers very seldom have accidents because they do follow such careful regulations.

THE CAUSES OF ACCIDENTS

Perhaps enough has been said to show that safety education covers a broad field, that it has to do with many situations, and that it concerns every individual, no matter what type of vocation he may follow. Let us turn our attention for a moment to some of the types of situations which produce accidents and which make safety education such an essential part of today's educational program.

Our accident picture. The record of deaths and injuries attributable to accidents in America is not one of which we may feel proud. Each year nearly 100,000 deaths are traceable directly to accidents; over 300,000 permanently disabling injuries come from the same source; while the number of minor injuries reaches 8 to 10 millions. This means that *every day* nearly 300 persons are killed in America, nearly 1,000 permanently disabled, and over 25,000 receive more or less serious injuries. These deaths and injuries are traceable to accidents, most of which could have been prevented if all persons concerned had been properly educated as to safety education procedures and had acted accordingly (Fig. 179).

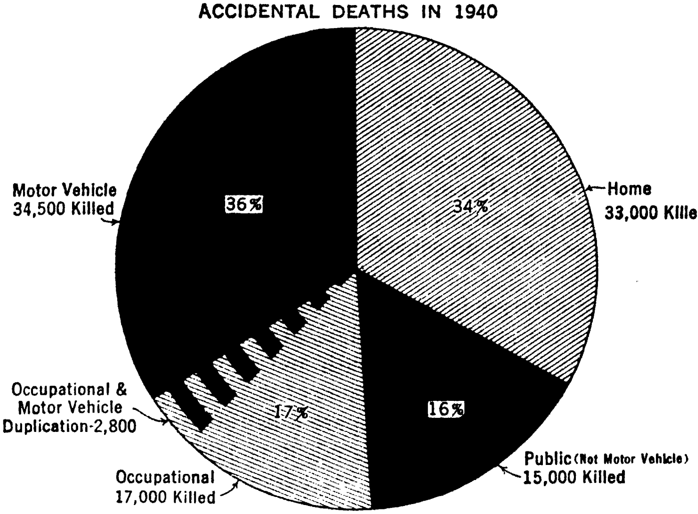


● Source: U.S. Census Bureau.

179 Motor vehicles and falls are easily the outstanding specific causes of accidental deaths in America. (From *Accident Facts*, courtesy of National Safety Council)

It is hard to visualize such figures, but if you can imagine as many people as can be packed into the largest athletic stadium in America, all killed by accidents within a period of one year, you will get some conception of the accident fatality rate in America. Similarly, if you can imagine that 1 in every 15 people in America will receive a more or less serious injury in some accident during the coming year, you will get a still better picture of the accident toll.

About one third of the deaths are traceable to automobile accidents; another third to home accidents; and the rest to industrial, athletic, and other accidents (Fig. 180). The bicycle alone is responsible for over 700 deaths and 30,000 injuries each year.



● Source: Approximations based on U.S. Census Bureau data, and state and city reports

180 Accidents are distributed about one third each to motor vehicles, homes, and general public miscellaneous situations. (From *Accident Facts*, courtesy of National Safety Council)

The prevention of accidents. Various agencies have entered the field of safety education in an effort to reduce the accident toll. The National Safety Council, the American Red Cross, the National Conservation Bureau, the American Automobile Association, and many local automobile associations have accomplished excellent results through their various agencies. Doubtless their efforts have accounted for much of the reduction in accident toll.

If a greater reduction in accidents is to be made, however, it will be necessary for every organization, every institution, and every individual to co-operate in a democratic manner in an all-out effort to save lives and prevent injuries. Perhaps the most important thing is to get every individual more safety-minded. Since this is an educational problem, the teaching staff and student body in our high schools should be able to do much to improve the situation.

Conclusion. The picture described in the preceding pages should be such as to make you agree that safety problems really constitute one of your major concerns. The older generation has not reached a satisfactory solution. The major responsibility must rest on the leaders of tomorrow. *You* hold the key.

ACTIVITIES

1. **Self-check on your study of this problem.** See if you can answer all the questions in the study outline of this problem. Discuss them in class.
2. **A study of accident hazards.** Prepare a list of things which seem to you most likely to develop into serious accident hazards in the next few years if preventive measures are not taken. Enlist the help of a group of classmates and really do something toward eliminating some of these hazards.
3. **Promoting safety-mindedness.** Bring up for class discussion, or for consideration in some group or club, ways in which schools and other agencies can help to make both youth and adults more safety-minded. As a group try to carry out one or more of the plans you suggest.
4. **Developing safety skills.** Prepare a list of the types of skills that you think a modern high-school student should develop in order to become a safe member of society. Start immediately to develop one or more of these skills that you do not already possess.
5. **How stable are you?** Make a study of yourself and see whether you are well controlled at all times, intellectually, emotionally, socially, and physically. Are you sure of yourself in all situations? Can you make your muscles do just what you want them to do? What particular weaknesses can you recognize that could be improved by training, experience, and practice?

SUGGESTED REFERENCES

American Automobile Association, *Pedestrian Protection*, Washington, 1939.

Beaty, John Y., *Story Pictures of Transportation and Communication*, Beckley-Cardy Co., Chicago, 1939.

Holbrook, Stewart H., *Let Them Live*, The Macmillan Company, New York, 1938.

Kreml, Franklin M., Stiver, M. F., and Rice, T. B., *Public Safety*, Bobbs-Merrill, New York, 1940.

National Safety Council, *Accident Facts*, Chicago, published annually.

—— *Community Safety*, 1937.

Problem 26. *Can Athletic Sports Be Made Safe?*

> The important thing in the Olympic Games is not winning, but taking part — the essential thing is not conquering, but fighting well. — BARON DE COUBERTIN

STUDY OUTLINE

A. How to choose your sports
  1. Why should you have a medical examination before participating in sports?
  2. Why should you follow your doctor's advice on activities?
  3. Is it possible to be successful in sports in spite of physical defects?

B. How the athlete can protect himself
  1. What special techniques will help you to avoid accidents?
  2. Why are training and conditioning necessary to athletic success?
  3. Can student-leader corps help in preventing accidents?
  4. In what ways does poor sportsmanship encourage accidents?
  5. How can you avoid serious injury in athletics?

C. How to avoid the chief hazards of specific sports
  1. How does failure to conform to the spirit of the rules encourage accidents?
  2. Should girls use boys' rules in basketball? Why?
  3. How can the chief hazards of team games be avoided?
  4. What can you do to make tumbling safe?
  5. Can hunting be made safe for the hunter? How?

MOST red-blooded American boys and girls have a natural and keen desire to be athletes and to take part in a variety of sports. This is a fine ambition and in most cases can be satisfied. Sports will contribute much to your development. It is important, however, that they be adapted to your individual ability and general physical condition. For some people certain restrictions must be observed for safety's sake.

HOW TO CHOOSE SPORTS

Occasionally a student is found with a defective heart or other vital organ. Some may be undernourished or suffering from incipient tuberculosis. Some are afflicted with hernia (rupture), or they may have structural defects such as spinal curvature or flat feet which might be made worse by strenuous activity. Still others are recovering from recent operations which would interfere with such participation.

The medical examination. Whether physical defects exist can be determined only by a thorough health examination given by a reputable physician. If your school does not provide such medical service, urge your parents to arrange with the family physician to give you a thorough checkup. Then ask him to tell you in what activities you can safely participate.

The doctor will not generally have to deprive you of the pleasure of participating in any of the ordinary sports. In case you happen to have any of the types of defective conditions mentioned above, he may ask you to omit the most strenuous sports such as basketball, football, or tennis, either temporarily or permanently. He may even prescribe milder activities, such as golf, archery, table tennis, horseshoes, or swimming.

Some students who have been advised to avoid certain activities have responded in a bravado spirit that they are willing to take a chance, and they think that they are all right. Some of them have found later, much to their sorrow, that the doctor was right. Their action has resulted in a temporary condition perhaps becoming a lifelong defect. The intelligent thing is to take the doctor's advice and follow it closely.

Success in spite of defects. Occasionally some defect such as blindness, the loss of an arm or leg, a serious heart disorder, or a crippled condition following infantile paralysis may necessitate a permanent restriction in activity. It is surprising, however, what the ambitious individual with a strong will can accomplish to offset defects. An infantile paralysis victim a few years ago became national rope-climbing champion. One-armed boys and girls have become experts at golf, baseball, and tennis, while one-legged men have become expert apparatus gymnasts and swimmers.

In other words, regardless of your physical capacities there are some games which you can learn to play well and enjoy. You have a right to the physical, mental, and social benefits of such participation, and should look forward to developing a variety of sport hobbies for use in later life *within the limits of any defect you may happen to have.* Be sure, however, to choose those which do not involve a risk of greater injury to yourself or others because of your defect.

HOW THE ATHLETE CAN PROTECT HIMSELF

National studies show that the dangers in many sports are due chiefly to poor condition, improper supervision, and the use of unsuitable equipment and playing areas. This indicates that the athlete himself should be particular about the playing area and the supplies he uses.

The techniques of self-protection. Learn the safest methods of playing the game, such as the correct form in sliding for a base, or tackling an opponent in football; and do your best to secure correct and safe equipment such as shoes, trousers, and shoulder and hip pads (Fig. 181). Always wear socks or stockings in order to avoid possible blisters and infection. Special protection should be provided for weak joints or other sensitive spots. Bandages or adhesive tape may be used for strapping weak ankles or wrists.

Avoid contact or collision with team mates or opponents, as this causes a large percentage of serious injuries. Be exceedingly careful in handling equipment that, by its very nature, is dangerous as, for example, baseball cleats, track spikes, shots, and baseball bats. Learn to fall properly, when tripped, tackled, or otherwise caught off balance. It is possible to develop techniques to take up much of the force of the fall by rolling sideward or forward, thus reducing the possibilities of injury. In falling, the weight should never be thrown forcibly on an extremity, such as knee, wrist, shoulder, elbow, or hand. An excellent method is to follow the Japanese Judo method of rolling sideward and up onto the feet, or forward into a ball as is done in the forward roll in tumbling. Be on the alert for possible irregularities on the playing surface, slippery spots on the floor or ground, other players getting in the way, or apparatus that is broken or insecure. It is not cowardly to be on the lookout for danger. If you anticipate danger before it arrives, you will avoid many accidents.

181 The successful football player must be in the "pink of condition" and be properly equipped.

The importance of athletic training and conditioning. Training and conditioning are essential to successful participation in strenuous athletics. A strong body may get by reasonably well without training in some sports, particularly under easy competitive conditions. Intensive competition, however, requires that both mind and body be in the pink of condition. Those activities which involve highly co-ordinated skills require keen judgment and fine decisions. Careful training will help put you in condition to perform at your best.

Conditioning and training practices are not as rigid today or as specific as they were in former years. In athletic conditioning practices, one of the most important things is adequate rest, preferably nine or ten hours a night in a well-ventilated room. The diet should include adequate quantities of vegetables, fruits, and milk, together with meat, eggs, or fish. Rich pastries and excessive amounts of sweets should be avoided. Meals should be eaten regularly and at least three times a day. Coaches recognize alcohol and tobacco as harmful to athletes, and recommend that they do not handicap themselves by such indulgence.

Student organization for accident prevention. Has your school ever tried the student-leader corps, or the squad-leader plan, to help in preventing athletic accidents? Many schools have found this very effective. It is considered a great honor to be selected as a member of such a group, and usually large numbers of applicants are on the waiting list. Leaders are given regular weekly training covering the athletic activities to be presented during the subsequent week. This includes instruction in how to protect participants from possible accidents, and how to organize a game setup and give instruction in performance techniques. Leaders are taught to be constantly on the alert to recognize weaknesses on the part of players, to remove them from the game if necessary, and to put them in such activities as will not be too dangerous for them.

A school sports safety committee is also used in many schools with success. This committee may be given assignments covering regular physical education periods, noon hours, recesses, and after-school athletic periods.

Good sportsmanship versus accidents. Just as good leadership is almost certain to improve morale and thereby decrease the probabilities of accidents, so, too, will good sportsmanship. The friendly, enthusiastic, co-operative spirit of *everyone for the team and the team for everyone*, is bound to give the individual a chance to play at his best. Girls particularly need to stress such team spirit, because in the past they have generally been considered less sportsmanlike than boys in their play. If individual and selfish desires are subordinated in the interests of the team, and particularly if each player keeps in mind the welfare of the opponent and is careful not to take undue advantage of him, accidents will become increasingly less frequent.

Helps in avoiding injury. In order to avoid accidents, particularly to muscles and tendons, it is exceedingly important to warm up thoroughly prior to entering regular competition or heavy practice. To avoid chilling and possible colds, it is advisable to wear a sweater or jacket when resting between periods of actual exercise. Be exceedingly careful to see that all gymnastic and athletic equipment coming in contact with your body is kept scrupulously clean and in good sanitary condition. Each person should have an individual clean towel daily. If you must wear glasses in order to see clearly, they should be of unbreakable glass, or a protective eye mask should be used.

It is important never to tire yourself to the point of exhaustion,

182 Learn your football fundamentals thoroughly if you would avoid injury and possible permanent damage to bones and joints.

as this will not only subject you to a higher probability of accidents, but will also weaken you as a team member. If you feel you are unable to do your best, ask the coach or captain to remove you from the lineup. Similarly, report to the coach all injuries, blisters, bruises, and scratches so that you may get adequate medical attention immediately. Sometimes minor injuries result in serious infections. *Never participate in strenuous games until you are not only in good condition, but have thoroughly mastered the fundamentals* (Fig. 182).

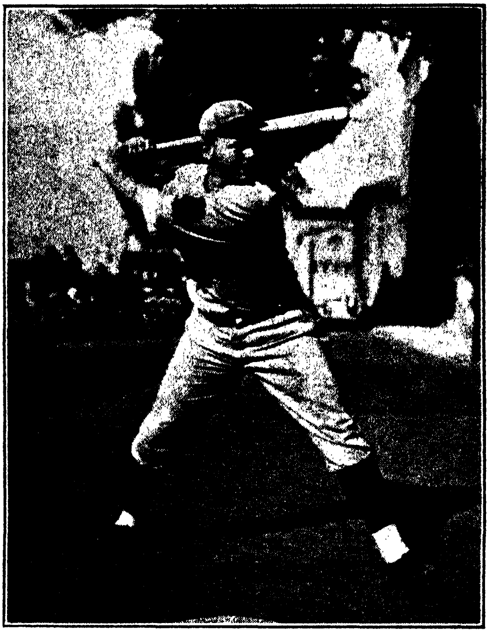
Girls should be especially careful to avoid overfatigue, and to modify their activities during menstrual periods. Light exercise at such times, however, is often beneficial both mentally and physically.

Since inattentiveness, or daydreaming, is the cause of many accidents, train yourself to be constantly on the alert. Alertness not only helps you to avoid accidents, but makes you a much better player.

A common practice in some schools where weight teams are used is that of attempting to reduce by excessive sweating so as to make a lighter weight team. This is dangerous since it affects the health of the player, and also depletes his energy and vitality, thus making him more subject to serious accidents.

HOW TO AVOID INJURY IN SPECIFIC SPORTS

When you become safety-minded, you will automatically do many little things to prevent accidents. In all sports, however, there are



183 Handle the bat with great care — it is a dangerous weapon.

certain hazards with which you might not be familiar without specific warning. Some of these are common to most sports. Others, however, are peculiar to the individual sport. This section calls attention to some of the more important of the latter. These safety hints apply just as much to the student in a physical-education class as to major-sport team members, and usually to girls as well as to boys.

Football. This sport has resulted in more injuries than any other. A survey by Dr. Floyd Eastwood, of Purdue University, shows that the most specific causes of injuries are: (1) careless mental attitude of the player, (2) lack of skill in executing football fundamentals, (3) poor playing-field surfaces, and (4) being kicked by an opponent.

Another study of football injuries in the Los Angeles high schools, by J. F. Costello,[1] indicates that most accidents occur in the early season. Fractures are the most common form of injury. Line bucks, end runs, and off-tackle plays were the chief causes of injuries, the majority resulting from collisions and pile-ups. This type of evidence emphasizes the importance of learning the fundamentals of the game early in the season. Such knowledge will, in turn, prevent most injuries resulting from ignorance and lack of skill.

Baseball and softball. Always be sure that the baseball bat is taped or otherwise treated so that the handle will not be slippery. Don't throw the bat after hitting the ball (Fig. 183). Have a definite spot on the ground on which the batter must drop the bat as

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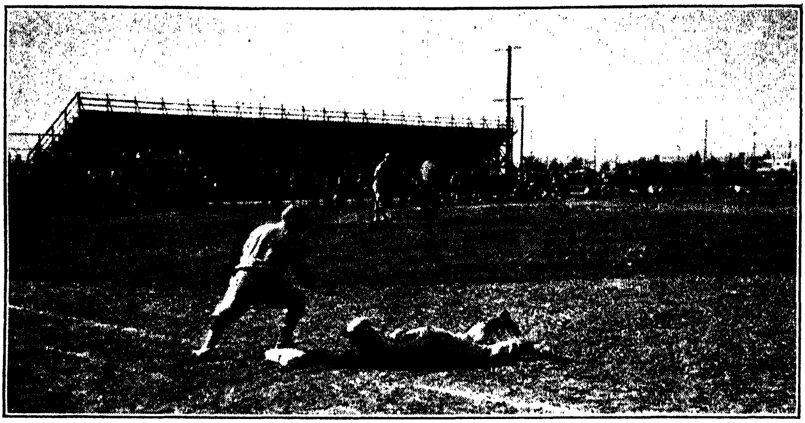
[1] Unpublished Master's Thesis. University of Southern California. Los Angeles.



184 *Never use the head-first slide* — it is too dangerous. Use the "hook slide" instead. It is difficult to learn, but very effective.

he starts for first base. Step out of the batter's box to keep out of the line of a thrown ball while a play is being made at the home plate.

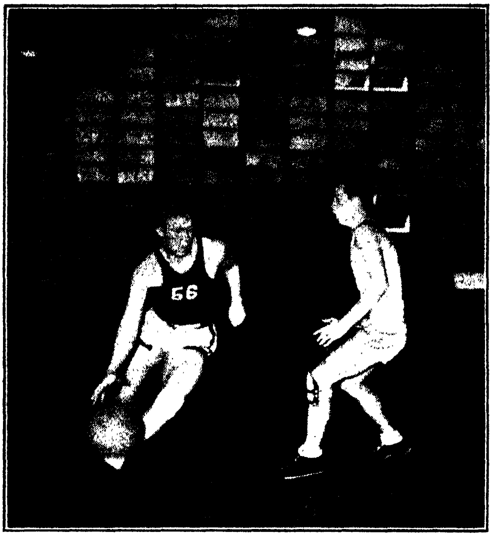
Head-first sliding is usually not permitted because of its danger (Fig. 184). The hook slide to the outside corner of the bag is most effective and probably the safest. It requires a great deal of practice under close supervision and instruction. Preliminary practice is best done in a sawdust pit or on soft ground.

The catcher, even in softball, should always wear glove, mask, and chest protector. It is important that fielders have signals whereby each will know who is to attempt a fly ball, so as to avoid confusion and possible collisions. Basemen should stand on the outside corner of the base while runners are rounding the bag.

Soccer and speedball. Players should be careful to avoid unnecessary roughness in making bodily contacts, particularly pushing, shoving, kicking, and tripping. Each should watch the ball closely at all times to avoid being struck by it. Properly fitted shoes are essential to safety in each of these games.

Boxing and wrestling. Both these sports are excellent body developers. The rules for amateurs are rigid enough to eliminate most serious accidents.

In boxing, you should attempt to outpoint and outsmart your opponent, rather than to punish him with hard blows. If possible,



185 Body contact can be avoided only by the greatest care.

a regulation ring and proper floor mats should be used. Twelve- to fourteen-ounce gloves are the most suitable. Headgear will prevent cauliflower ears and a nose protector will shield you from fractures. Be sure never to compete with anyone out of your weight class.

Wrestling should be done on strictly sanitary mats. Washable mat covers are the most satisfactory. All dangerous locks and toe holds should be strictly barred. Never pick up an opponent and throw him forcibly to the mat. Mat burns are very common and require first-aid treatment similar to other burns.

Basketball. Accidental contacts are bound to develop between players because basketball is a fast game played on a small court (Fig. 185). Players who fail or refuse to conform to the spirit of the rules, and make unnecessary bodily contacts, should be barred from the game.

If end and side spaces on the court are less than 10 or 12 feet, the area should be protected by mats hung on the wall. Wet or slippery spots on the floor should be dried before play or practice starts. If you play on outdoor courts, remember that gravel surfaces are treacherous. Basketball should not be played on any hard surface, such as cement.

Girls frequently want to use the boys' rules for their basketball game. This practice is considered inadvisable because the boys' game is rougher and permits each player to cover the entire court; also, it involves too much body contact. The girls' rules make possible an excellent game. Stick to them!

Skating and skiing. If you are fortunate enough to indulge in

186 Good balance and fine co-ordination will help you avoid sprained ankles.

winter sports, be sure to learn the fundamentals of skating and skiing thoroughly before attempting them alone. In skating, see that your shoes fit well and that the ankles are properly protected and braced. Skate only where there are other skaters, or in areas that are supervised. Keep away from unknown territory and particularly areas marked "Dangerous."

In skiing, secure strong and dependable equipment, and take the first steps and tumbles on the level and then on gentle slopes before trying any steep runs. Avoid runs where there are possibilities of collision with trees, fences, or other objects, and do not attempt steep runs with which you are not familiar. If you fall in the ski path, be sure to roll out of it as quickly as possible.

Hockey. In both field and ice hockey the stick may become a dangerous implement unless wielded strictly within the limitations of the rules. Tossing the ball or carrying through with the stick beyond the permitted height frequently results in serious injury.

Tennis and badminton. Neither of these games is very hazardous. A nonslip grip on the racket handle will help avoid accidents from flying rackets. Sprained ankles sometimes result from coming down incorrectly from a high stroke (Fig. 186), or from turning quickly or slipping on wet spots or on irregularities on the court surface. Don't play on wet courts!

Track and field.[1] These events are relatively safe with the pos-

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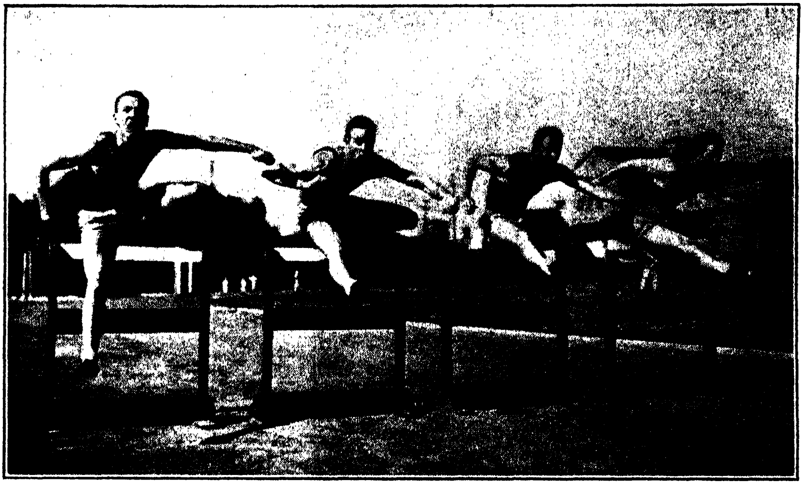
[1] It is a general practice to discourage most track and field events for girls with the exception of short-distance running and milder forms of jumping.



187 Keep the lead leg straight for good form and to avoid accidents. Perfect timing and rhythm are essential to successful hurdling.

sible exception of the shot, discus, pole vault, javelin, and perhaps the hurdles. Remember that muscles and tendons are readily pulled when cold, and should be warmed up thoroughly.

The use of track shoes with spikes may at first be disconcerting to a beginner, as the spikes tend to stick in the ground. Adjust yourself to them gradually to avoid turning an ankle. Running the distances, particularly, may also seriously affect the heart if overdone. The condition of the heart should be determined by a thorough periodical medical examination.

In pole vaulting use only a foolproof pole which cannot break. If bamboo poles are used, they should be inspected frequently for possible cracks. Well-taped aluminum poles are considered safest.

Hurdling, particularly the high hurdles, may be dangerous because of spills resulting from striking the bar with the leading foot. This danger can be minimized by keeping the leading leg straight (Fig. 187).

The shot put, discus throw, and javelin are considered very dangerous activities. In fact, most high schools have eliminated these entirely from competition.

Tumbling. This is one of the best all-round activities available for the high-school student. It can be made relatively safe pro-

188 Somersaults are fun but too dangerous for beginners. Learn fundamentals first.

vided each individual learns simple stunts first, works up gradually to the more complicated ones, and does not undertake foolhardy stunts. Aerial tumbling, such as forward and backward somersaults and hand springs (Fig. 188), should be attempted only after you have mastered the correct execution of the elementary fundamentals. As a rule, only the simplest forms of tumbling are recommended for girls because of the greater possibility of injury from falls and the jar of landing.

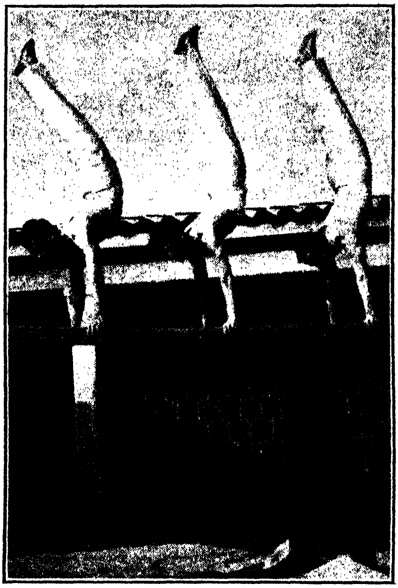
When tumbling on the gymnasium floor, be sure to use well padded mats, in sufficient quantities. Take care never to land on the edge of the mat or on the floor. Sand at the sea shore, or sawdust pits, or well-spaded ground may also be used. When attempting somersaults or similar stunts, use the safety belt, or a substitute such as two towels twisted around the waist of the performer and held by assistants. A tightly rolled mat under the spot where the performer will operate also gives fair protection.

If heavy-apparatus work is attempted, it should be done only under the close supervision of an instructor, beginning with very simple exercises and gradually working up to the more difficult ones. It is important that adequate mat protection be provided on the floor surrounding the apparatus (Fig. 189). Spotters (assistants) should be used always to help protect the performer against possible accident.

Archery. The bow and arrow, made famous in stories by the adventurous Robinhood, has excellent possibilities both as a target sport and for hunting purposes. By its nature, however, it involves certain definite risks that must be guarded against.

Be sure not to stand closer than 4 feet to another archer on the same line. Do not attempt to retrieve arrows until all members of the group have shot their "round." Use finger guards and wrist gauntlets to guard against abrasions, string burns, and bruises. Examine arrows and bow frequently for possible cracks or breaks.

Hunting. Hunting is one of the most hazardous sports. Each year over 2,500 persons are killed accidentally in America by firearms. Many accidents are traceable to playing with "unloaded" guns, and to inexperienced hunters shooting at moving objects without being sure what they are.



189 Advanced apparatus stunts require fine balance and coordination plus safe equipment.

Carelessness in handling guns probably is the cause of practically all firearms accidents. When carrying a gun the safety lock should be on and the muzzle pointed either up or down. Loaded guns should not be taken into automobiles or other conveyances. If you must climb through a fence push the gun through muzzle first and lay it on the ground, then climb through the fence yourself at a safe distance from the gun.

The only safe practice in handling either loaded or unloaded guns is the rigid rule of never pointing a gun at any person or thing at which you do not intend to shoot. Even the seemingly harmless air rifle or BB gun has been responsible for many serious accidents.

Conclusion. In general, we may conclude that if the present progress toward improved supervision and equipment continues, and the individual athlete is thoroughly trained in how to protect himself and others, the hazards of athletics should be markedly reduced. All sports, however, will continue to be attended by certain hazards. Injury can be avoided only by constant watchfulness.

ACTIVITIES

1. Self-check on your study of this problem. Answer all the questions in the study outline of this problem. Discuss them in class.

2. Your sports program. Make a list of the activities which your doctor has approved for you, and in which you hope to participate. Arrange them in order of your preference. Make a separate list of any which he may have disapproved. Start practicing approved activities.

3. Training and conditioning plans. Do you follow a strict and definite program of training and conditioning to keep fit for sports activities? If not, prepare such a schedule, and try it out conscientiously for a month to see if it isn't justifiable.

4. Athletic safety checkup. Arrange to have a committee survey the gymnasium and athletic fields, and report in class all defective conditions that might cause accidents. This committee might also serve as a safety squad to inspect the facilities.

Athletic Safety Habits

Check yourself on the following habits. Do you —

a. Wear clothing that is clean and appropriate for the sport?
b. Have all skin breaks properly treated to prevent infections?
c. Watch for slippery spots and cracks on playing surfaces?
d. Watch to avoid collisions with teammates, opponents, trees, fences, and other obstacles?
e. Handle yourself skillfully on your feet, keep your balance, and turn quickly?
f. Train and condition yourself regularly?

SUGGESTED REFERENCES

Lloyd, Frank S., Deaver, G., and Eastwood, F. R., *Safety in Athletics*, W. B. Saunders Co., Philadelphia, 1936.
National Safety Council, *Safety for Supervised Playgrounds*, Chicago.
Sanders, J. Edward, *Safety and Health in Organized Camps*, National Bureau of Casualty and Surety Underwriters, New York, 1931.
LaPorte, Wm. R., Hunt, Chas., and Eastwood, F. R., *Teaching Safety Education in Secondary Schools*,* Prentice-Hall, New York, 1942.
Lloyd, Frank S., *Safety in Physical Education in Secondary Schools*,* National Bureau of Casualty and Surety Underwiters, New York, 1933.

* For advanced students and teachers.

Problem 27. *How Can Swimming Be Done in Safety?*

> To swim with ease and confidence and grace
>   Should surely have acknowledged place,
> By recognition and by law decreed
>   Be taught as fully as we're taught to read.
> Forming a part of education rule
>   In every college and in every school.
>
> — OLD ENGLISH VERSE

STUDY OUTLINE

A. The values and hazards of swimming
   1. Why is swimming an excellent aid in growth and development?
   2. What are the chief hazards in swimming?
   3. How could most drownings be prevented?

B. Safety in the swimming pool
   1. Why is a pool director's position important?
   2. What does a life guard do besides save lives?
   3. What are the essential steps in life saving?

C. Safety in ocean swimming
   1. Why is surf bathing hazardous for inexperienced swimmers?
   2. How do experienced swimmers enter the surf?
   3. What technique should be followed in diving through breakers?
   4. What would you do if caught in a rip tide?

D. The "dos" and "don'ts" of ocean swimming
   1. What are the most important things to do to insure safety at the beach?
   2. What practices should be avoided in ocean swimming?

HOW well do you swim? We do not ask, "Do you swim?" since we assume that you do. If not, certainly you should learn at the earliest possible opportunity. Do you swim with confidence and assurance? Do you feel at home in the water? Can you relax and let the water carry you like a cork? Do you know that you will float without sinking unless you happen to be one of the very rare specimens of man whose specific gravity is too great?

Do you know several standard swimming strokes well? Could you swim a long distance if necessity required, and float occasionally to relax your muscles? Do you know what to do to rescue a drowning person and take care of him afterward? Have you passed the Red Cross Junior or Senior Life Saving Test?

THE VALUES AND HAZARDS OF SWIMMING

Swimming is so very important to you that we are devoting an entire problem to it. It is one of the most valuable all-round activities for body development known to the physical-education world.

Swimming as a developer. For the past 12 years a national committee[1] has been conducting research to determine the types of activities to be included in physical-education programs for public schools and colleges. Over thirty athletic activities were evaluated by hundreds of experts from all parts of the United States. These experts rated swimming as most valuable of all activities in its contribution to individual development from the *physical, social, mental, safety,* and *recreation* standpoints. This was a remarkable record for an activity, and as a result strong emphasis has been given to the building of pools and the teaching of swimming in schools throughout the United States.

The hazards of swimming. Swimming, however, in spite of its many advantages and values has certain drawbacks. In the first place, water, to be safe for swimming, must be very carefully purified and sterilized. *Good* pools that are constantly purified, however, contain water far cleaner from the bacteriological standpoint than most of the water you drink.

Many people suffer from respiratory disorders, particularly of the upper nasal area, commonly known as sinus infection, or sinusitis. It is the opinion of many physicians that persons with sinus disorders should never enter the water for swimming purposes. In some cases, at least, swimming seems to induce or increase the severity of such conditions.

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[1] College Physical Education Association, *The Physical Education Curriculum — A National Program,* The University of Southern California Press, Los Angeles, 1939.

It is advisable for *everyone* to eliminate long underwater swims, to do very little deep or high diving, and to modify slightly those swimming strokes, such as the crawl, in which the head is kept mostly under water (Fig. 190). The most important thing, however, is to learn to breathe properly, inhaling only through the mouth.

Many of you live in areas where there are no controlled pools or beaches, and where you swim only in the "ole swimmin' hole" in stream, river, or lake. If so, you will not have the protection of sterilized water nor possibly of life guards. In many such swimming places you may face the definite danger of contaminated water.

Your local health department should be able to tell you whether the water in your "swimming hole" is fit for swimming; if not, don't take a chance. If you don't have a life guard, why not organize a life-guard crew among your gang of good swimmers? Appoint one as Captain of the Guards; have him assign members to duty at different hours; and in addition give them special training in life saving. The local American Red Cross Life Saving representative will assist you in this. If you will also institute the "buddy" system by which two persons always swim together and look after each other, you can make your "swimming hole" relatively safe.

Preventing drownings. Many drowning accidents could be prevented if the individuals concerned could avoid fear and panic and would observe a few simple precautions. Unfortunately, however, the inexperienced nonswimmer when thrown into the water gets panicky and attempts to climb out of it, waving arms and legs vigorously. Such exercise merely forces him under the water and increases his difficulties. Standing up in the water is the thing not to do; but even in this position if one would simply be quiet and breathe in only when the head is out of the water, he would have no serious difficulties. Buoyancy will be increased, however, if he will lie flat on his back in floating position.

Many drownings of experienced swimmers are due to cramps over which they have no control. If the cramp occurs in the feet, legs, or arms, the good swimmer can usually roll into a floating position, massage the cramp, and continue swimming. If a severe stomach cramp occurs, however, he will have greater difficulty.

190 If you are subject to sinus trouble, keep your head out of the water. It is possible to do so even in a crawl stroke.

To avoid stomach cramps swimmers should never enter the water for at least an hour after eating a meal, and preferably not for two hours if the meal has been a heavy one.

SAFETY IN THE SWIMMING POOL

Many accidents also occur in and around pools and other swimming places because of careless conduct of swimmers.

Swimming-pool problems. Perhaps it might help you better to understand and appreciate the hazards of swimming if you were to take the point of view of the pool director or life guard who is responsible for hundreds of swimmers. Let us suppose that you have been appointed to serve as a pool director in a large city pool. You would be expected to see that the pool water was kept in perfect condition so that it would meet state health requirements. This means that the water must be bacteriologically clean and must be clear enough so that objects can be seen on the bottom at the deepest point at any time, night or day. You would not permit bathers with colds or any type of skin infection, or anyone wearing a bandage to enter the pool. You would not permit persons in street clothes to walk on the deck at any time. This is, of course, to prevent contamination of the water.

You would require patrons to take a thorough soap shower before entering the pool. You would not permit swimmers to run on the slippery deck surfaces, because experience has shown that many serious head and elbow injuries occur from slipping while running. You would not permit scuffling or wrestling on the deck, nor countenance rough play or splashing water within the pool; and would see to it that children leave the pool before their overstay does damage to their health.

What the pool guard does. If you were the pool guard, you would be expected to prevent any rough-house play in the water, such as ducking, playing tag, or other dangerous or reckless forms of activity that might cause accidents; to keep all weak or nonswimmers at the shallow end of the pool; to keep all swimmers away from the diving board area to avoid accidents in diving; to allow no dangerous stunts in the pool or on the diving boards; to permit no diving into shallow water or playing on or around ladders.

You would be sure that all life-saving devices, such as body hooks, poles, ring buoys, and lifelines, were in good condition. You would check the attendance record at the end of each session to be sure that all swimmers had left the pool; and you would even make an underwater inspection, patrolling the depths of the pool at all points at the end of a session to be sure that no one might accidentally have drowned and remained under the water. During the hours you are on duty as guard, you would refrain from conversation with patrons or visitors, for fear that this might distract your attention from the duty of constantly watching swimmers. Before leaving the pool, you would see that all swimmers were out, and that all entrances were locked, so that no one could enter the pool while it was unsupervised.

SAFETY IN OCEAN SWIMMING

The preceding sections have given you a good idea of the hazards connected with pool swimming, and what can be done about them. Many of the same principles apply to swimming in lakes and streams. Ocean surf bathing, however, offers entirely different problems in many respects.

Ocean hazards. Most swimmers are ignorant of hazards they will encounter when they enter the surf. The modern guard, accordingly, attempts to advise the swimmer, and will indicate whether the surf is too heavy for safety, and where there are particular hazards such as rip tides, submerged rocks, pilings, or bad currents running under piers. Each of these constitutes a major hazard for the beach swimmer.

As a life guard on a typical ocean beach you would find it necessary repeatedly to warn enthusiastic swimmers against taking long-distance swims alone; or going into the water too soon after eating; or using floating apparatus which is not dependable. Even a strong swimmer is not safe in going far from shore unless accompanied by a boat or a companion who is also a strong swimmer.

Floating apparatus should not be used by anyone except good swimmers. Many feel that if they have a well-inflated inner tube or similar equipment, they can go into the surf without fear. They do not realize that the ocean breakers have a terrific power, and may tear them loose from the supporting apparatus or carry them out far beyond their depth. The inflated apparatus may then collapse, leaving the victim helpless if he is not a swimmer.

For actual swimming in comfort, you will wish to go just beyond the line of the breaking surf to quieter water. Remember, however, that this is usually beyond your depth; hence, you should be a strong and capable swimmer in order to do it safely. You may have been standing in water not over waist deep and a series of heavy breakers may put you entirely beyond your depth. Therefore, if you are a beginner, do not go into deep water in the surf. Incidentally, the experienced swimmer will follow the example of the life guard on entering the water; namely, instead of diving headlong into an incoming breaker, he will wade in to approximately waist deep and then swim off.

The technique of surf riding. Many inexperienced swimmers get badly "churned" while attempting to swim through the breakers. Remember that many hundreds of pounds of water pressure will be hurled against you at the point of a breaking wave. High breakers on steeply sloping shores are exceedingly hazardous. The strongest of men cannot stand against them, and in the curling crest the body is absolutely helpless.

If caught in one of these churning breakers you will have the sensation of being torn almost limb from limb. You may be dashed upon the bottom and unmercifully rolled and hammered against the harsh sand. Sometimes backs are badly wrenched.

It is important to "know your breakers." The essential thing is to avoid the main volume of the curling breaker, and to present the least possible resistance to the water as you cut through. Remember the rule when going through a breaker — head into it and keep the body as straight as possible. Hooking the thumbs together, with arms straight over the head, will help to knife through. Above all, don't double up and don't spread the arms and legs from the body.

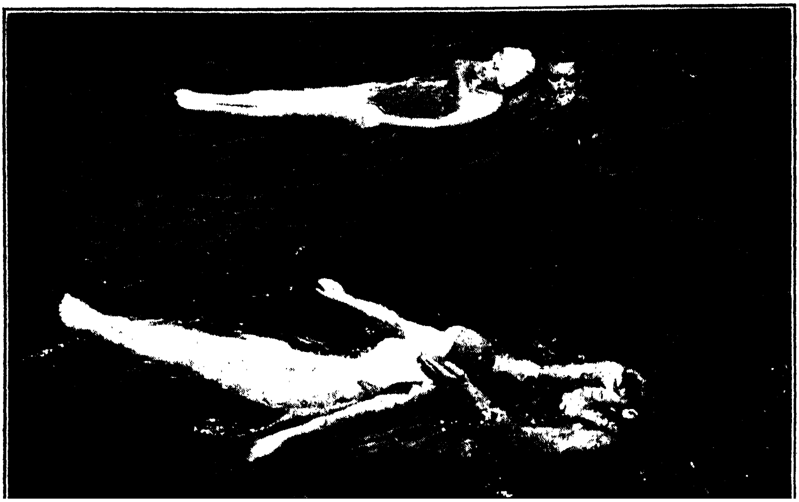
Rip tides. Probably the greatest single cause of drownings and of rescues in ocean swimming is the rip tide. This is an off-shore current caused by two lines of waves coming in on shore at a converging angle, resulting in a pile up of water at this point. The extra water pressure, rushing down the slope of the beach, digs a gully, with a strong current running out to sea. Usually this strong current will stir up sand from the bottom and cause a discoloration in the area of the rip tide.

The current may continue as far as a quarter of a mile or more out to sea, and will be similar to the current of a river. It may be several times as strong as the best speed of the swimmer; hence, if caught in one, it is impossible to swim against it. The only practical method is either to float with the tide until it subsides, and then wait for help, or swim to shore; or, swim parallel to the shore until you reach quiet water, whence a return to the beach can be made.

Above all, do not struggle against the current in a rip tide, as this merely fatigues you without gaining any headway. In some areas rip tides are more or less permanent; in others they come and go, depending upon the local conditions. Life guards are usually informed as to where these are most likely to occur.

The approach to life saving. As a life guard you would also be expected to sponsor a life-saving club in order to encourage more swimmers to become life savers. Life saving today, however, is not what it used to be. The old technique was to dive in and swim spectacularly to the rescue of a struggling victim, strike him on the chin to knock him unconscious, then take him by the hair and tow him to shore and safety. Today, the would-be life saver, if he is intelligent, uses swimming as a last resort in rescuing the drowning.

The Red Cross suggests the life-saving slogan, "Throw. Row.



191 Overambitious beginners often have to be pulled out of the surf by the guards. The cross-chest carry (*top*) is most frequently used. (Courtesy of Los Angeles Department of Playgrounds and Recreation)

Go." This means that if the victim is within the reach of shore or bank and is conscious, toss him a life buoy or other object that will help support him temporarily. If he is far out from shore it is best to secure some kind of boat and row to him. If boats are not available and you must swim to him, approach the victim with great care. If you can carry some object such as a rope or stick or even a handkerchief for him to grasp, it is safer than to take him by the hand. If he is panicky, he will probably grab you tightly, possibly around the neck, and then you may both need a rescuer.

The drowning person should be approached from the rear if possible. If he is struggling violently, stay at a distance and tell him quietly that you will help him if he becomes quiet, but otherwise you will leave him. If this does not suffice, the rescuer can wait until the victim has exhausted himself struggling, then attempt to tow him, using some one of the holds recommended by the Red Cross. The cross-chest carry is most effective with a struggling victim, and is most commonly used (Fig. 191). The tired-swimmer's carry is by far the easiest if the victim is quiet and can help to support himself. Usually it is preferable for the rescuer merely to support the victim until help arrives if any appears available. You will find it interesting as well as valuable to make a careful study of the various breaks and carries for life saving.[1] A brief description of artificial respiration technique is given on page 446.

Life guards to the rescue! Have you ever seen a life-guard rescue? It is a thrilling experience and one you will never forget. When the call for help is sounded, the life guard scrutinizes the area until he spots the struggling swimmer, if necessary using binoculars or a telescope; he notes the conditions, the difficulties to be met, and what probable help will be necessary. He telephones headquarters to send the call car, which is immediately dispatched with additional life guards, inhalators, first-aid equipment, blankets, and stretchers. If advisable, a motor boat may also be sent to the spot.

The guard enters the water with a rubber life tube, or a torpedo can swung over his shoulder, and swims to the point where the victim is struggling (Fig. 192, *top*). He may use a surf board, depending upon water conditions and the location of the victim. Occasionally a surf boat is used. If there is more than one victim, he will attach the tube or can to the weakest one and then bring the others to it to await further help (Fig. 192, *center*). A can or tube will support several victims with bodies submerged, and just the heads out of the water. A surf board will support as many as eight or ten with the bodies submerged (Fig. 192, *bottom*). If necessary, after the victim is safely ashore, the inhalator equipment is immediately put into action; and other first aid is given.

BEACH SAFETY DON'TS

As a result of their many years of experience in making beach rescues and studying the causes of accidents on the beach, the Los Angeles Recreation Department has formulated an interesting set of *Beach Safety Don'ts*. These have been given wide publicity from time to time, and probably have done much to make swimming safer for beachgoers. The "Don'ts" in the form of a safety code for beachgoers appear on page 491.

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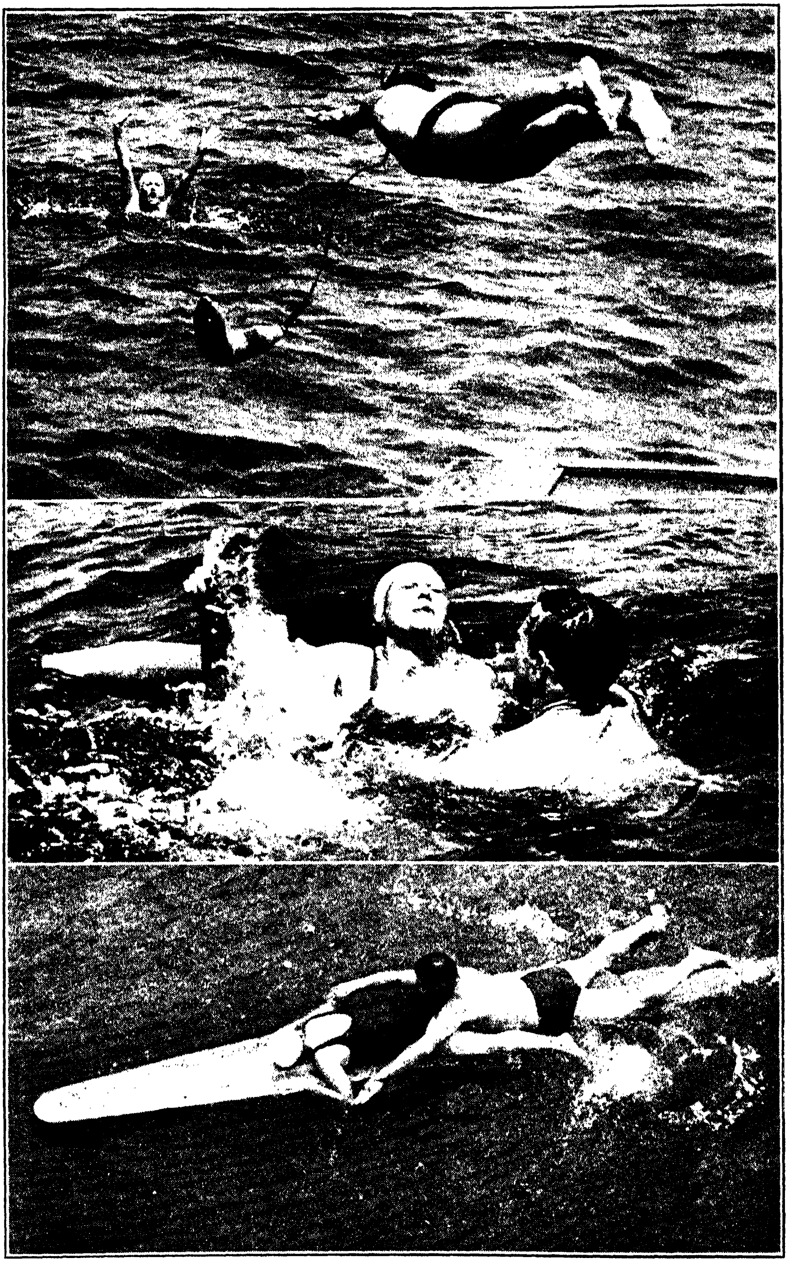
[1] See American Red Cross Manual, *Life Saving and Water Safety.*



192 *Top.* A guard leaps to the rescue; (*center*) attaches life tube to victim and tows her to the boat. *Bottom.* In some cases he may use a surf board. (Courtesy of Los Angeles Department of Playgrounds and Recreation)

Beach Safety Don'ts [1]

1. Don't swim near rip tides; they are dangerous. Find out from the life guard how to recognize them and combat their effects.
2. Don't overestimate your swimming ability, especially during the early part of the season.
3. Don't bathe in remote places; stay near a life guard's position.
4. Don't bathe immediately after eating; cramps, temporarily paralyzing in their effects, frequently result.
5. Don't swim near piers or piling; they have dangerous currents and sharp cutting edges.
6. Don't dive into unknown water; explore it thoroughly in advance.
7. Don't make long-distance swims unaccompanied by a strong swimmer or a boat.
8. Don't use inflated play apparatus in the surf, such as tire tubes, water wings, and floats. You may be carried out to sea and be unable to return.
9. Don't call for help unless actually in trouble; but if you do need help, don't hesitate to call immediately for assistance.
10. Don't take dares in the ocean.
11. Don't go to the assistance of a life guard unless he asks for it; he might have to rescue you as well as the original victim.
12. Don't try to acquire a quick tan; painful sunburn is usually the result of such an attempt.
13. Don't throw sharp glass, tin cans, or other dangerous refuse on the beach; help to keep it clean.

Conclusion. While swimming is easily the outstanding activity for assuring you superb physical development, it is also hazardous. Since most people sooner or later will have to face the threat of drowning, the logical safeguard appears to be, *every high school student a swimmer.*

Many schools, unfortunately, do not provide swimming pools, hence you may have to secure instruction and practice at a public pool or in a river or lake. But — *learn to swim* — *somewhere!*

You will be relatively safe if you will get accustomed to letting the water support you, develop the proper breathing technique, perfect one or more standard swimming strokes, and observe the swimming precautions outlined in this chapter for the use of pool and beach, or the old "swimming hole."

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[1] Nicholls, C. P. L., *Beach Water Safety* (mimeographed bulletin, Los Angeles Department of Playground and Recreation).

ACTIVITIES

1. Self-check on your study of this problem. See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. Community swimming facilities. Survey all swimming facilities in your community — school, public, commercial, and private pools, and natural swimming holes in streams or lakes. Do they conform to the health and safety requirements described in this problem? If not, what steps can you take to improve the situation?

3. Life guards. If you have a natural swimming hole in lake or stream, and do not have a regular life guard, prepare a plan for an amateur life-guard club, a "buddy" system, and other necessary safety precautions, to make swimming safe in your community.

4. Swimming safety code. On the basis of class discussion, prepare a concise but comprehensive *code for swimmers* that you can recommend to all beginners. Such a code should cover all safety standards and practices essential to safety in pool, "swimming-hole," or beach swimming.

Swimming Safety Habits

Check yourself on the following habits. Do you —

a. Swim only in approved places and near a life guard?
b. Swim only distances easily within your ability?
c. Wait a reasonable time after eating before swimming?
d. Depend only on your own swimming ability — not on floating play apparatus?
e. Refuse to take dares in the water?
f. Acquire your sun tan gradually?
g. Help keep the swimming beach clean?

SUGGESTED REFERENCES

American Red Cross, *Life Saving and Water Safety*, Blakiston's Son, Philadelphia, 1937.

—— *Swimming and Diving*, 1938.

Boy Scouts of America, *Swimming, Water Sports and Safety*, Washington, D.C., 1938.

Lloyd, Frank, Deaver, G., and Eastwood, Floyd, *Safety in Athletics*, W. B. Saunders Co., Philadelphia, 1936.

National Safety Council, *Accident Facts*, Chicago; published annually.

Problem 28. *Can Traffic Hazards Be Reduced?*

He who learns to look each way may live to drive another day.

STUDY OUTLINE

A. The relation of the driver to accidents
  1. What is the chief cause of traffic accidents?
  2. Does a good driver expect other drivers to make mistakes?
  3. Can you suggest a good slogan for safe driving?
  4. What constitutes "fitness" for automobile driving?

B. Building safer automobiles
  1. Are most people capable of becoming good drivers? Why?
  2. To what extent can automobiles be made foolproof?
  3. Would you favor the use of speed governors on cars?
  4. In what ways are traffic accidents more serious today than formerly?
  5. To what extent would slower speeds reduce accidents?

C. Training drivers to avoid accidents
  1. What is a good recipe for becoming a safe and expert driver?
  2. What highway defects tend to cause accidents?
  3. To what extent are accidents due to physical defects of drivers?
  4. How does alcohol affect driver efficiency?
  5. What speed does your headlight illumination justify at night?
  6. By what characteristics could you recognize the "good driver"?

EVERY nine seconds someone is *injured* in a motor vehicle accident in the United States, making a staggering total of 3,000,000 persons each year. Every 15 minutes someone is *killed* in a similar traffic accident. Every hour 4 people are killed. Every day nearly 100 are killed; and for the total year — and every year — 37,000 meet death in some kind of automobile accident.

The irony of it, however, is that most of these accidental deaths could have been prevented by intelligent, thoughtful, and courteous action on the part of the drivers. The American public has become motor-minded, and the automobile is with us to stay. Something must be done to make both rider and pedestrian safe.

THE RISING TIDE OF AUTOMOBILE ACCIDENTS

Thirty million motor vehicles in the United States are being driven by over forty million drivers of varying ages over three hundred billion road miles per year. The number of vehicles is also increasing at a rapid rate, while the registration of drivers eligible to operate them continues even faster. These factors, together with the rising speed limits, promise a still greater death toll, unless something drastic is done to prevent it.

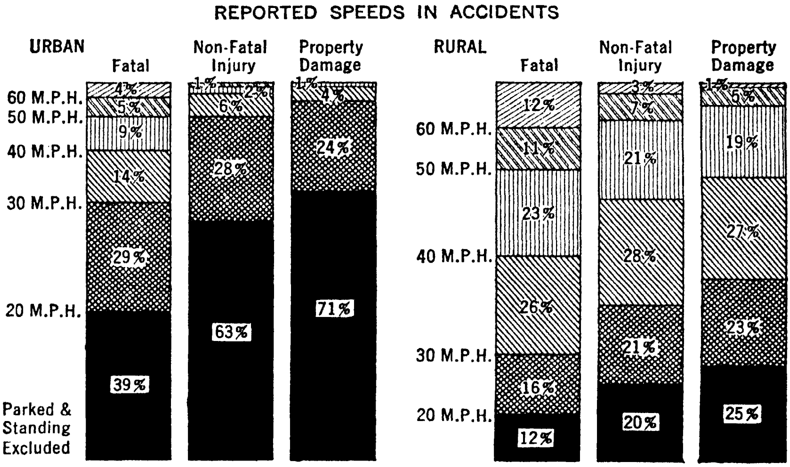
Responsibility for accidents. Most accidents are *not* due to the condition of the automobile, the road, or the weather. Approximately 85 per cent occur in clear weather; only 15 per cent happen when it is foggy, raining, or snowing. It is easy to place the blame on the other fellow or to say it was the weather, a defective car, poor roads, or poor lights. The evidence, however, seems to indicate that it is the driver who is responsible. In approximately 25 per cent of the accidents he did not have the right of way; in 16 per cent he was on the wrong side of the road; in 10 per cent he was driving recklessly; in 5 per cent he was cutting in; and in still another 5 per cent he crashed the signal.

The pedestrian is also a careless contributor to accidents. He is usually injured while crossing between intersections (jay walking) or against the signal; or where there is no crossing signal; or in coming from behind parked cars; or, in the case of children, running into the streets.

Why drivers are careless. Psychologists believe that much carelessness among drivers is traceable to emotional instability. Many seem to have a superior attitude toward their fellows and the automobile offers them an excellent medium to express their feelings.

Those persons who have acquired a high degree of courtesy in other social situations are most likely to be courteous in their driving. Other things being equal, the courteous driver is also most likely to be the safe driver. The selfish and discourteous driver is bound to be unsafe. Hence, it would seem advisable for the beginning driver to develop a high sense of social responsibility and the habit of courteous, considerate, and sportsmanlike driving (Fig. 193).

The good driver's point of view. Unfortunately, a vast majority of new drivers today are being taught by an army of older drivers who themselves have never had any technical or scientific training in correct driving. Thus drivers' faults go on from generation to generation. You will be wise if you insist upon securing your preliminary driver training from someone who is an expert; one who not only knows how to handle a car skillfully, but who can tell you all the most significant hazards that you will have to meet as a driver; and one who also knows just what each of the thousands of other drivers on the road is most likely to do that would jeopardize your safety.



Source: Special reports from seven states, 1940

193 Speed is a major factor in many accidents. (From *Accident Facts*, courtesy of National Safety Council)

It might be a good idea for the new driver to adopt the following slogan to govern all of his future driving: *I will expect the other driver to make mistakes. I will not get upset when he does it, because I know he is just being childish. I will also keep myself constantly alert to see that I am not in his way when he makes the mistake.*

Fitness to drive. In learning to drive you will want to become an expert master in handling the mechanical aspects of your car; but it is equally important that you develop a right attitude of mind and an emotional balance that will not be disturbed by the conduct of other drivers. The time, doubtless, will come when in every state licenses will be issued only to those persons who have demonstrated the ability to handle a car well in every conceivable situation. Drivers must realize that when they are issued a driver's license, they are being given a *privilege* and not a *right* to operate an automobile.

BUILDING SAFER AUTOMOBILES

Many engineers and traffic experts are becoming convinced that the majority of people cannot be developed into expert drivers because of their physical, nervous, and emotional limitations. No amount of training, apparently, will entirely make up for this lack of native ability. It seems evident, then, that if most people cannot become expert drivers, the only solution of the accident problem is to make the automobile itself more or less foolproof.

Designing cars for greater safety. Safety engineers are now giving increasing attention to the possibilities of making the automobile so safe that the average driver cannot easily meet with a serious accident. You may have seen newspaper-article or magazine illustrations of the "tear-drop" principle applied to the automobile shape. This involves a blunt rounded head with the body tapering gradually almost to a point at the rear, comparable somewhat to the shape of a whale's body. Older models have followed a shape almost the reverse of this, with greatly reduced efficiency and much increased wind resistance. Manufacturers are now attempting to swing in the direction of the tear-drop shape, but only to a limited degree because of the demand for style.

In addition to the improved shape, this car would be slung much lower on the axle, with the motor placed at the rear to make the car better balanced, and less likely to skid. It would also place the driver in the extreme front with a much improved vision of the roadway ahead. Placing the engine in the rear would also eliminate to a large extent the cases of carbon monoxide gas poisoning, which apparently have accounted for many accidents where the driver has fallen asleep or been overcome with fatigue.

Automatic governor controls. Much has been said for and against automatic governors on automobile engines to limit the top speed of cars. The need for something of this kind is becoming increasingly evident because of the almost unlimited power developed in modern automobile engines. The top speed of the better cars of today is far beyond the limit that any ordinary driver can possibly handle with safety, even with the best of roads; and with the average roads now available, such top speeds are suicidal.

In earlier days collisions rarely resulted in fatalities. In present-day high-speed crashes, however, the impact of a collision is so tremendous that, as a rule, every passenger in the vehicle is killed. In fact, the possibilities of unlimited damage and destruction to other lives and properties is so great that it is doubtful if society will continue to grant the driving privilege to untrained, unskilled persons, many of whom have poor judgment, poor physical condition, and often an absolute disregard for the rights of others.

Many large industrial institutions have for years required top-speed governors on all their operating trucks and machines. They find almost universally that it reduces accidents; increases the efficiency of drivers, because of less nerve strain; lengthens the life of the car; reduces repair on the engine and automobile; and reduces lawsuits and insurance costs.

Someone has estimated that if all vehicles operating on rural roads were automatically limited to a top speed of 60 miles per hour, it would reduce accidental deaths by approximately 15 per cent; and that if speeds were limited to 40 miles per hour, this reduction might be as much as 60 per cent.

The problem of enforcing highway speed regulations and restricting the careless driver, however, is a very difficult one, because of the tremendous number of people and machines involved and the area to be covered. Obviously, 30,000 traffic officers cannot adequately enforce regulations for 40,000,000 drivers and cover 3,000,000 miles of roadway. This would require each officer to be responsible for 1,000 automobiles and an average of 100 miles of road.

TRAINING DRIVERS TO AVOID ACCIDENTS

It will be a long time before the many suggested improvements in cars described above can be effected. Even after every possible improvement has been made, however, the final factor that will prevent a given accident will be the driver himself.

Need for driver training in high school. We will assume that you are interested in becoming one of the best drivers on the road, if your abilities will so permit. It will require your very best intelligence together with the highest degree of skill you can possibly develop in handling cars. In addition, you will need to be constantly on the alert to avoid accidents, and conform to all local and state ordinances and laws which have been designed to protect drivers, passengers, and pedestrians. *Safety requires making careful driving your only business while you are at the wheel.*

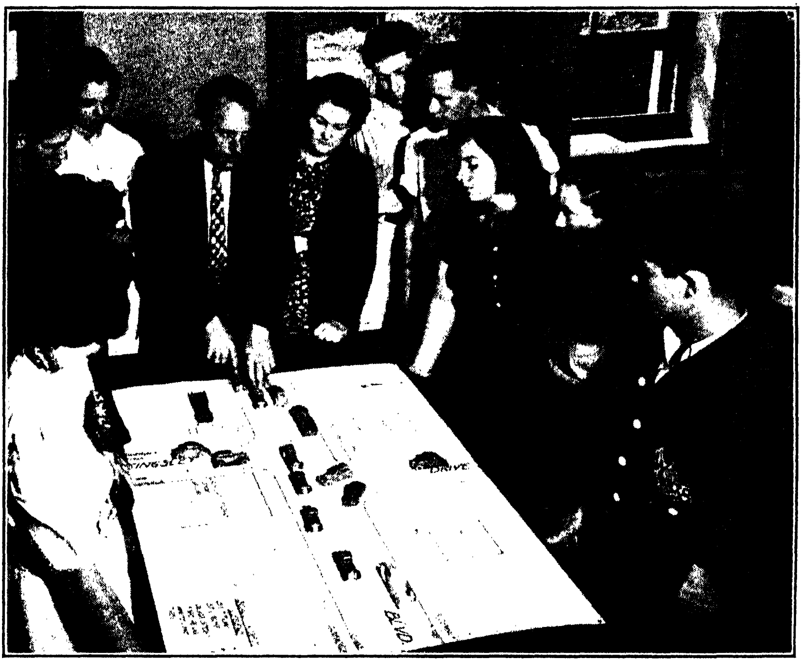
Highway defects sometimes cause accidents. It is important that you be constantly on the alert for roadway conditions that may interfere with the perfect functioning of your car. There is a wide variety of road surfacings — some of them firm, others treacherous. Wet spots on an otherwise dry road are always dangerous, as are also patches of ice or snow, or wet leaves.

In many cases the road may be crowned so high in the middle as to tilt your car dangerously. This calls for reduction in speed. Curves may be excessively sharp, without proper banking. Many curves are difficult to judge; hence, they should be approached with caution. Putting on the brakes after entering a turn is very dangerous, as this throws the weight of the car toward the outside arc of the curve. Slow down *before* entering the curve.

One of the valuable safety precautions is the rapidly growing practice of installing in new highways some separating barrier to keep the two lines of traffic entirely apart.

Soft shoulders just off the main paved area constitute serious hazards and should be avoided carefully. If forced onto them, you should not apply the brakes heavily, but attempt to keep the car pointed straight ahead and gradually slow down.

It is important that you give special attention to intersections, particularly the so-called blind crossings where vision is restricted and you cannot see oncoming traffic. Cars may be approaching on the other roadway at high speed in the hands of careless drivers who are not concerned about blind crossings. If they are traveling at 60 miles per hour, it will take them over 200 feet to stop. Hence, you do not want to be in the middle of the crossing when they arrive. It is wise to slow down and let other cars at intersections have the right of way even though it may legally have been yours. Claiming or demanding the right of way at crossings is responsible for many serious accidents (Fig. 194).



194 Study of intersection problems may be simplified by use of miniature cars on a street diagram. (Courtesy of Los Angeles Board of Education)

Vehicular defects as causes of accidents. Brakes, whether of the automatic hydraulic, or the mechanical type, need frequent checking. The cylinder fluid in hydraulic brakes should be frequently inspected and refilled, and the brake lever should be checked for adequate clearance. Always be sure that your car can be stopped within the proper braking distance.

Doubtless you have seen safety tables indicating the relative distances required to stop cars at different speeds when brakes are in good condition. It is important enough, however, to repeat here to refresh your memory. The stopping distance at various speeds is approximately as follows:

Miles per hour	*Feet to stop*
30	73
40	115
50	165
60	225
70	300

At 70 miles per hour you would be traveling over 100 feet per second. On an ordinary city street, with average-sized blocks, if you were going at that rate, and saw a child in the middle of the street a block away, and immediately put your foot on the brake with all your force, you would reach the child in less than three seconds and would be unable to stop for some distance beyond that point. Obviously, there would be no remote possibility of saving the child.

Incidentally, from a safety standpoint, a good driver uses engine compression in first or second gear when coming down steep hills, to avoid overuse of the brakes. In fact, this is the law in many states. Compression can also be used effectively for safe braking on slippery streets and in heavy traffic. It is important, however, to use great caution in shifting gears on wet streets. It is good policy to practice the use of second gear under difficult traveling conditions, either on poor roadways or in congested traffic.

Physical condition of the driver. Certain types of physical defects make the individual unfit to operate an automobile at any time, as for example, serious heart defects, epilepsy, and defective sight or hearing. A minor form of defect which seriously affects driving is what is commonly known as "tunnel vision." Persons with this condition have a very narrow range of vision laterally. Hence, they are unable to observe cars approaching from side streets, except by actually turning the head in each direction. Such persons should voluntarily drive much more slowly, and enter crossings only after having looked carefully each way by fully turning the head. In fact, this is a good safety practice even for persons with normal vision.

Color blindness is another defect responsible for some accidents. Night blindness, inability to see well against headlights, has been found recently to be caused by lack of vitamin A.

General physical condition is probably a more important cause of most accidents than actual physical defects. Fatigue is one of the major causes of accidents of certain types. Falling asleep at the wheel, and losing consciousness from carbon monoxide poisoning both result in numerous accidents. If you should become excessively fatigued or sleepy while driving and have no relief driver, the only safe solution is to pull off to the side of the road and take a short nap before continuing.

195 School children and other pedestrians should use underpasses whenever possible. (Courtesy of Los Angeles Board of Education)

Alcohol is a major cause of accidents, and unfortunately intoxicated drivers seem to be on the increase. Alcohol and gasoline do not mix in *any* quantities or proportions. The man who has had even a small quantity of liquor is unfit to drive under modern traffic conditions. If a person indulges in alcoholic drinks, he should either get someone else to drive for him, or take a taxi. A good slogan is: *If you must drink today, don't drive until tomorrow. If you must drive today, don't drink until tomorrow.* It is equally important not to take chances by riding with any driver who has been drinking.

Pedestrian hazards. Doubtless, you have noticed that pedestrian deaths are on the increase. This is traceable partly to the increasing number of automobiles on the highways, and partly to the marked increase in speeds. The pedestrian who walks 3 or 4 feet a second is no match for the automobile which streaks over 100 feet per second. Someone has facetiously remarked that "the pedestrian is a vanishing race." At any rate he accounts for one half or more of all automobile-traffic fatalities.

Many pedestrians have never driven a car, hence do not realize the dangers they face in traffic. The pedestrian is particularly vulnerable at night. He can see the lights of the oncoming car clearly, in fact, may be blinded by them; but if he is in a shaded area or is wearing dark clothing, the driver may not see him at all. Pedestrians who wear light clothing or carry some white object when walking on the highways at night are much safer. In an automobile age, however, the pedestrian will doubtless always be the major traffic problem. He will have to be protected by better crossings, signals, underpasses (Fig. 195), overpasses, and other mechanical devices.

The pedestrian should cross streets and congested areas only at patrolled intersections, waiting for the proper signal, and even then being sure that the way is clear of traffic. He should take advantage of all special lanes or underpasses, and should never walk diagonally across the street. On rural roads he should walk facing the traffic, and wear some white object at night. He has just as much legal right on the highway as the driver of a vehicle, but he should not take advantage of this right.

A large percentage of pedestrian deaths are small children who either play in the streets, or who suddenly dart out from the sidewalk to recover a lost ball (Fig. 196). When driving in residential areas, or near schools where children may be about, use exceptional caution. If the streets are narrow, keep as near the middle of the street as possible; drive slowly; and always be on the lookout for children. In fact, expect a child to dash out from behind every parked car or other obstruction along the curb. If you take this attitude, you will be much less likely to have to face the horrible experience of carrying a limp, crippled, or dead child in to his parents.

Bicycle hazards. Bicycle riding is closely related to the pedestrian problem, and is a major cause of accidents. The safe cyclist inspects and keeps his bicycle in good condition at all times; avoids congested streets and highways; displays a white head lamp and red tail light or red reflector at night; obeys all traffic laws; uses arm signals when stopping and turning corners; does not hang

196 Playing in the street or running into the street after a ball is a frequent cause of pedestrian accident. (Courtesy of Los Angeles Department of Playgrounds and Recreation)

onto streetcars, automobiles, trucks, or busses; does not carry an extra rider; rides with the traffic and on the right-hand side of the street or highway; does not ride zigzag nor do trick riding on the streets; does not dart in and out of moving traffic; gives pedestrians and automobiles the right of way; always slows up and looks both ways before crossing an intersection or coming out of a driveway; and always rides with caution and courtesy.

Visibility conditions as affecting accidents. Ordinary headlights will illuminate the roadway with reasonably good visibility for only 200 feet. It naturally follows then, that if you drive in excess of 50 miles an hour, you would not be able to stop in an emergency within the limits of the area illuminated by your headlights.

Under fog conditions use either the right edge of the road or the white line down the center as a guide. The headlight beam is best directed downward as this causes less reflection of light from the fog particles. A pair of good fog lights will help materially in bad fogs.

Diversion of attention. Are you a back-seat driver, or do you annoy your driver by carrying on a constant conversation with him while in heavy traffic or on dangerous roads? If you do, *don't!* You are a potential killer. Do you crowd in as a fourth passenger on the front seat, and thus handicap the driver? In most states there are laws against overcrowding the driver's seat, yet one of the happy-go-lucky practices of many high-school students is to load the old "jallopy" to the limit and then have a hilarious ride.

When you are driving, follow the practice of keeping your eyes focused constantly on the road ahead. Taking the eyes off the road for a second or two to look at your companion, or to view the scenery, may be disastrous. Remember that at even moderate speeds your automobile will cover a long distance in a period of a second. If you must view the scenery, pull off the highway and stop.

Driving skill. Study the possibilities of your car and develop good driving skills. The car should become a part of you, just as the horse becomes, apparently, part of a good rider. The two work in unison. The first step is to get the feel of your car when under perfect control, then keep it there *always*. "Under control" means that you can make the car do what you wish *at any time*.

You may already be a good driver, but perhaps a few suggestions on driving techniques will help you to improve your skill. Some of these items we have already mentioned, but they will bear repetition. Have you ever ridden with drivers who gave you the jitters; who drove jerkily, and never seemed to have the car completely under control; who would put on the brakes so suddenly that you were thrown forward in your seat; and who all in all evidenced a complete lack of emotional and nervous stability? You have doubtless ridden with others with whom you felt completely at ease. They start off without a jerk; they slow down gradually for stops and manipulate the brakes so that you glide smoothly to a standstill. In fact, they ordinarily anticipate stops far enough ahead so that they can use the brake well in advance.

Smooth driving. The good driver moves in and out of traffic without cutting in on others or stealing the right of way from anyone. He watches traffic congestion and selects lanes that are open. He has his car ready for the start at intersections so that he does not have to "jump the gun" on a signal, but still gets away without holding up traffic behind him. If he is driving slowly, he keeps in the right-hand lane; does not toot his horn in a traffic jam; does not "show off," nor boast about how fast he can drive; and does not shout foolishly at drivers who get in the way.

If there is a question of right of way at a crossing, the good driver will stop and permit the other driver to go ahead just as he would accede a doubtful point to an opponent in a game of tennis or badminton. Similarly, when pedestrians are waiting to cross the street, particularly at cross walks, he stops and signals them to proceed. When in a neighborhood where children are at play, you will note that the good driver is exceedingly alert and careful, and drives slowly in readiness for a quick stop. He does not take chances.

You can learn much from a driver of the type described above, and it will pay you to observe closely not only his forceful conduct and courtesy, but his general intelligence and attitude toward driving, and his skill in operating his machine. Naturally, you will not be able to drive as smoothly as he does at first, but close observation and practice will make you increasingly more expert. If you will watch him carefully, you will note that in overtaking and passing other cars outside of business districts, he first sounds his horn, and throughout the operation allows ample distance so as not to crowd the car he is overtaking. He does not cut in quickly in front of it, nor until he can see it in his rearview mirror; finally, he returns to the right side of the highway before any approaching vehicle reaches a point 100 feet from his car. Such an operation calls for careful timing and judgment.

Safe driving. The expert driver also keeps well to the right of the road when approaching the crown of a hill. He does not attempt to overtake and pass another car until he has reached the top of the hill. Similarly, he will not attempt such passing on a curve. He keeps within traffic lanes. He uses his gears for brakes on steep hills. If he goes into a skid, he turns the front wheels in the direction of the skid, and removes his foot from the accelerator. If he must stop on very slippery pavement, he will probably leave the clutch engaged while applying the brake carefully and gradually until the car is almost stopped, to avoid skidding. In driving on such streets he may use second gear, for greater safety.

A good driver avoids jamming on the brakes except when compelled to stop suddenly on a dry road. Sudden braking tends to throw the car sideways, causing it to skid or perhaps overturn. This is especially dangerous on wet pavement, going down hill, when one wheel goes off the road, or in case of a blow-out. Under such circumstances the good driver holds the front wheels straight and slows down gradually. In rounding curves he enters at a reduced speed, and accelerates as he goes into the straightaway. He always gives proper hand signals, so they will be visible to cars following.

When he parks on a grade, he turns the front wheels toward the curb. In night driving he dims his lights out of courtesy to the approaching driver. When visibility becomes poor, because of darkness, fog, or rain, he slows down markedly. If a police or fire siren sounds he pulls over to the curb and stops. He does not pull out from a parking spot at the curb without first giving a thoroughly visible hand signal and waiting for other cars to pass.

He places safety above quibbling over the right of way. He stops at important highways regardless of whether there is a stop signal. He does not follow other cars too closely. He never coasts down steep hills with the gears in neutral or the clutch out. He is very careful to observe all safety zones. He complies respectfully with any orders from traffic officers.

Courteous driving. When another car signals a desire to pass, on a narrow road, the good driver either slows down or moves over. When overtaking or passing school busses, from either direction, he stops if the bus is receiving or discharging school children. He then proceeds past it at a safe speed of 10 miles per hour, observing special caution for the safety of pedestrians. He never passes on the left side of a streetcar; and always stops behind such a car when it is stopped. He does not make U turns in business areas except at permitted crossings; and in residence districts, only when no other vehicle is approaching within a distance of 200 feet in either direction. Similarly, he does not make U turns on a curve, or upon or near the crest of a grade.

He does not park his car on cross walks or intersections, or between safety zone and curb, or in front of public or private driveways, or in the second zone of traffic, or in tunnels. On the highway, if it is necessary to park, he pulls off the main road. He does not leave his automobile unattended without first stopping the motor and setting the brakes firmly. He is particularly careful on slippery pavements, narrow highways, bridges and subways, railroad grade crossings, intersections, curves, soft road shoulders, steep grades, and in night driving.

Such a list of attributes of the skillful driver may seem extensive, but every one of them is important. They are essential to safe driving. If you imitate this type of driver, you may hope to qualify as a skillful and safe motorist. Take pride in being a *good* driver!

Conclusion. You will now doubtless agree that a safe driving attitude is perhaps the most important single factor in preventing accidents. If all drivers will conform reasonably well to established traffic regulations and common courtesy; if the public will modify its style demands to permit safer car design; if highways and intersections are made safe; if only the "fit" and the skilled are licensed to drive; and if the pedestrian can be guaranteed reasonable safety, traffic fatalities *can* be reduced.

ACTIVITIES

1. Self-check on your study of this problem. See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. Study of pedestrian errors. Have a committee survey streets and crossings in the vicinity of your school, and list pedestrian practices that might easily result in accidents. What can you do to correct this situation?

Driving Safety Habits

Check yourself on the following habits. Do you —

a. Make *careful driving* your *only business* when at the wheel?
b. Refuse to get upset when other drivers make mistakes?
c. Keep your car always *strictly under control?*
d. Reduce speed appropriately when driving at night, or in fog or rain?
e. Use engine compression to control your car on steep grades?
f. Conform to the code of the smooth, safe, and courteous driver?
g. Refuse to ride with drivers who have been drinking?

3. High-school-driver defects. Discuss frankly in class the driving practices common among high-school students, which you think are not safe. Perhaps you can devise a *driver's safety code* to which other students could be asked to subscribe.

4. Driver's license test. Discuss in class the requirements of good driving. Use your conclusions as a basis for formulating a test to be given all beginners before the granting of a driving license.

5. Intersection problems. Secure a set of miniature cars; lay out a large diagram of intersecting streets; and experiment with various crossing problems, as in Fig. 194, page 499.

REFERENCES

American Automobile Association, *Sportsmanlike Driving* (Series of five) (driver training course), Washington, D.C., 1938. (Every driver should read these.)

Beadle, Kenneth, *Driver Training Procedure*, National Conservation Bureau, New York, 1939.

Bennett, Richard O., *The Bicycle and Traffic Safety*, Northwestern University, Traffic Safety Institute, Evanston, Ill., 1938.

Chase, Stuart, *Tragedy of Waste*, Macmillan, New York, 1929.

Killick, Victor W., *Can We Build Automobiles to Keep Drivers out of Trouble?* * Reeves Publishing Co., San Francisco, 1940.

Kreml, Franklin M., Stiver, M. F., and Rice, T. B., *Public Safety*, Bobbs-Merrill, New York, 1940.

LaPorte, Wm. R., Hunt, Charles, and Eastwood, F. R., *Teaching Safety Education in Secondary Schools*,* Prentice-Hall, Inc., New York, 1942.

Manual of Safety for Secondary Schools, Automobile Club of Southern California, Los Angeles, 1931.

Manual on Traffic Safety for California Secondary Schools, Printing Office, Sacramento, California, 1936.

Travelers Insurance Co., *Smash Hits*, Hartford, 1940. (Free.)

Union Oil Company of California, *How to Reduce Traffic Nerves*, Los Angeles. (Free.)

Whitney, Albert W., *Man and the Motor Car* (driver training course), National Conservation Bureau, New York, 1936.

* For advanced students and teachers.

Problem 29. *How Safe is Your Home?*

STUDY OUTLINE

A. Why modern homes are not safe
   1. What general conditions account for most home accidents?
   2. What ages are affected chiefly by various accidents?
   3. What makes the home so hazardous?

B. Taking steps to insure a safe home
   1. What is the value of a home safety checkup?
   2. How can you remove the hazards disclosed in the safety checkup?
   3. How can you educate your parents in home safety practices?
   4. What general standards would you propose for home safety?
   5. What are the chief characteristics and practices of the safety-minded person?

YOU are familiar with the old slogan, "Your home is your castle." In medieval times a man's castle was the one spot where he felt relatively safe. When pursued by enemies he galloped home, clattered noisily across the drawbridge, pulled it up behind him, and there he was, well protected by moat and high walls. He was safe at home.

You have held more or less the same conception of a modern home. As a youngster, when you had difficulties or disappointments, or were hurt in some manner, you hastened home to Mother and Dad and safety. Probably you still do the same thing in lesser degree, and this is as it should be. When things go wrong, it is fine to be able to go home for safety and comfort.

WHY MODERN HOMES ARE NOT SAFE

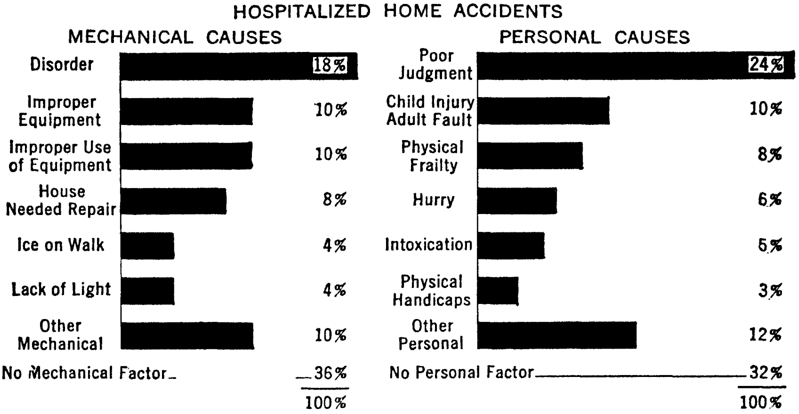
From the accident standpoint, however, something must be done to make these beloved homes of ours safer. At the present time you are safer at school than at home. You are safer even in industry; and almost as safe on the highway (Fig. 197). Statistics

197 You are safer hiking in the mountains than you are in the average home. (Courtesy of the Los Angeles Department of Playgrounds and Recreation)

show that each year over a third of all accidental deaths occur in the home — from 35,000 to 38,000 of them.

General causes of home accidents. Safety workers have shown that most home accidents are preventable, and are traceable either to some mechanical cause that should be removed, or to personal carelessness that could be modified (Fig. 198). Accident records show that approximately one half of the deaths in the home are caused by falls, and the remainder chiefly by burns, firearms, poisoning, suffocation, gas, and electric shock (Fig. 199). Apparently stairways, outside yards, and kitchens are the most hazardous areas in the home. Can you think of reasons why so many accidents should occur at these spots?

Unfortunately nearly a third of all home accidents claim as their victims children under 10 years of age. You can readily see why a baby or young child is most likely to fall victim to an accident. He is inclined to try anything once. He experiments with whatever he finds on the floor, in cupboards, and in wastebaskets. If open electric wall sockets are available, he pokes fingers into them. He turns on gas jets, and pulls tablecloths off to hear the dishes clatter; stabs himself, or falls on sharp-edged or sharp-pointed toys, pencils, and similar objects; climbs on chairs, tables, porch railings, and ladders, with disastrous results. The medicine cabinet is particularly attractive; and kettle handles extending out over the stove edge appeal to his curiosity. Stairways are a special attraction. He is forever trying to crawl up or down them, with poor success, or tumbles into them without seeing them. Open windows appeal to him tremendously, while wet or slippery floors catch him unawares.

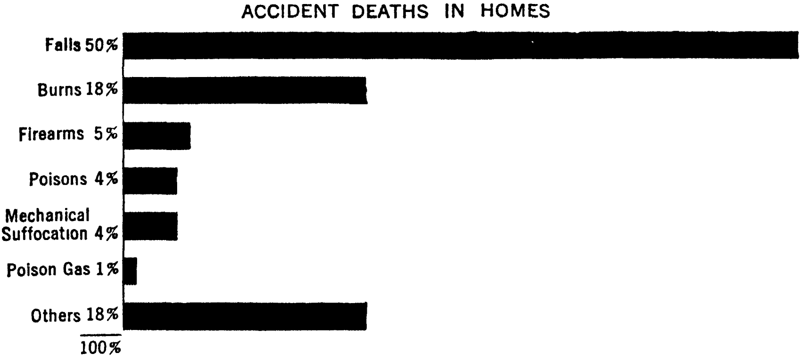


Source: 4,602 Home Accidents Hospitalized at Cook County Hospital, Chicago

198 Most home accidents could be prevented by use of better judgment, more orderly arrangement of homes, and the proper use of suitable equipment. (From *Accident Facts*, courtesy of National Safety Council)

Adults suffer from some of the same things that bring grief to the baby. They trip over loose objects on the floor or stairs (Fig. 200); catch toes in the edge of carpets or unmended holes; and slip on smooth or wet spots on the floor. Adults receive many burns from gas explosions, scalding water, or inflammable liquids; while poisoning, electric shock, and gas, all claim a high toll. Not all of these mishaps could be prevented, but most of them are avoidable. Inadequate lighting, improper placement of electric switches, poorly lighted stairways, objects carelessly left about rooms, in halls, and on stairs may seem harmless, but they all claim their victims.

Probably one of the commonest causes of falls is the small rug on a slippery floor without a protective mat under it. Another is the failure to use rubber mats in bath tubs and showers to prevent slipping. Still another is the foolish practice of climbing on rocking chairs, rickety ladders, or boxes to fix curtains, arrange pictures, or get something from a high shelf. Food carelessly spilled on the kitchen or dining-room floor causes many a serious fall, while unprotected stairways are death traps.



● Source: Three State Health Departments

199 Most home accidents would be eliminated if falls and burns could be avoided. (From *Accident Facts*, courtesy of National Safety Council)

Other causes of home accidents. Burns, scalds, and cuts constitute a major source of home accidents. The first two account for 4,000 to 5,000 deaths every year, bring permanent disfigurement to many, and minor injury to untold numbers. Carelessness in handling pans and kettles of liquids on the stove or in the laundry, or unduly exposed heaters, account for many of them. Failure to use holders when handling hot vessels causes the victim to drop the object with consequent scalding or burning. Carelessness in lighting gas stoves, particularly the oven, is a major cause. Many persons turn on the burner before striking the match, and the oven accumulates a sufficient quantity of gas before the flame reaches it, to cause an explosion.

Strange as it may seem, the home medicine cabinet, designed to take care of accidents when they do occur, has itself proved a major hazard. Most of these cabinets contain some poisons, and too frequently they are so placed that they are within the reach of small children. Aged persons with poor vision sometimes fall victim because they fail to read the label correctly, or possibly pick up the

200 Many stairway falls are due to objects carelessly left on the stairway, or to undue haste in hurrying up or down stairs.

wrong bottle in an absent-minded manner, without even looking at the label. Such accidents would largely be preventable if some of the recommended procedures were used for the marking of poisonous bottles: for example, a pin may be stuck through the cork, or a piece of adhesive tape over the top; or specially shaped bottles may be used; or rubber bands or string may be tied around bottles; or still better, all poisons may be kept in a separate locked cabinet.

The many electrical conveniences which characterize our modern homes have become prolific sources of death and serious injury. Probably you have had the experience of getting a minor shock from an electric switch or exposed cord in your home. If you had touched the electrical fixture with wet hands, or while standing in water, or on a wet surface, the shock might have been sufficient to kill you. The bathroom, the kitchen, and the laundry are the most hazardous places because they usually have numerous electrical fixtures and equipment in close proximity to water. They also have many metal pipes or other implements which serve to ground the electricity and increase the shock.

Other home conveniences which contribute to the accident record are can openers, kitchen knives, food mixers, electric fans, washing machines and wringers (Fig. 201), and other similar implements.

TAKING STEPS TO INSURE A SAFE HOME

Several years ago the American Red Cross launched an extensive and successful promotional program in the form of a home safety-checkup campaign. This was to advise the public as to the hazards existing in and about the home, and how to eliminate them. The plan called for the co-operation of the school and the home. Inspection blanks were taken home by thousands of students, who, with the co-operation of parents, made a detailed survey of all home hazards. They filled in the record on report blanks provided by the school or the Red Cross, and then returned them, properly filled out, to school officials.

Many children and parents alike had never before given specific attention to possible accident sources in their home. Many had thought that the home was the safest place on earth. It was accordingly quite a revelation to discover that the home was really a hazardous place. If you have not conducted such a checkup in your own home, you will want to do so at the earliest possible opportunity. You may be surprised to discover a great many items that could cause accidents. They have been there all the time, but had escaped your attention.

Having discovered the hazards that exist in your own home, the next step naturally will be to attempt to eliminate these as far as possible.

Removing hazards disclosed in safety checkup. In most cases it should be a comparatively simple matter for you to remedy inadequate lighting if there is such; to see that the floors are all sound; and that stairways and porches have proper railings. Where rugs are unsecured against slipping, it should be a simple matter to attach rubber pads, or even sew rubber rings from fruit jars under each of the corners. Other mechanical factors can be cared for such as placing screens in front of fireplaces, seeing that wood-

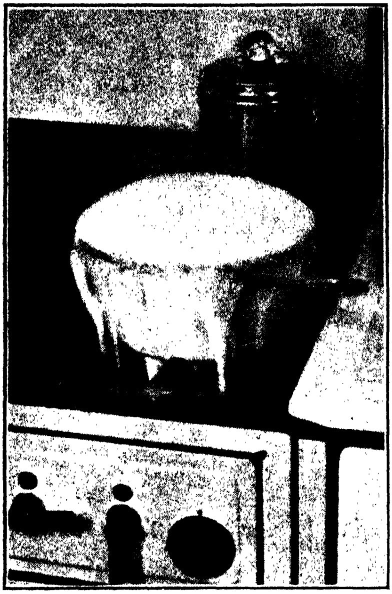
201 Serious injuries result from fingers carelessly caught in wringer rolls. Modern machines have semiautomatic releases.

work is protected from hot stoves or pipes, and making arrangements for prompt disposal of trash.

The gas company will usually make necessary adjustments in burners without charge and see that the gas connections are properly checked. Usually the electric-light department will also give free inspection of electrical appliances to see that they are in good condition. A definite policy can be adopted for the protection of poisons, and some member of the family designated to put this into effect.

General standards for home safety. If you were to describe the safety-minded home member, your recital might be somewhat as follows: Recognizing that falls, burns, asphyxiation, and poisoning represent the four main causes of accidents in the home, the safety-minded person gives most attention to these fields.

He sees that objects are not left where persons may stumble over them. He has steps, stairways, and halls well lighted, and un-



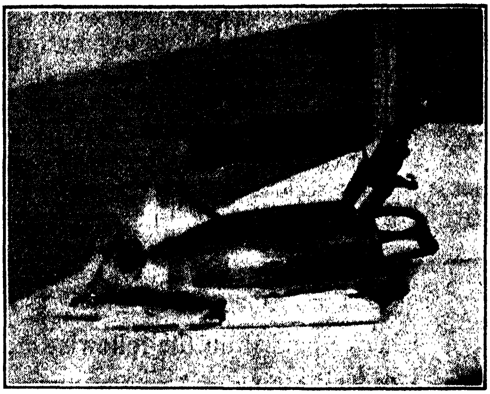
202 Many children are burned by pulling kettles from stoves, or by liquid boiling over. Boiling liquids also cause fires to go out, resulting in possible asphyxiation for persons in the room.

obstructed by boxes or chairs. He uses care in walking on polished floors, and sees that all small rugs have nonslip pads under them. He has railings on stairways, handles in showers and on the walls above bath tubs, and uses rubber mats in the bath tub or shower to prevent slipping.

He has a small stepladder in the house and always uses it for reaching high shelves or items on the walls or ceilings. He uses care that overhead cupboard doors are not left standing open. He uses safety matches, or keeps other matches in metal containers and out of the reach of children. He keeps fireplaces screened, and hot liquids out of the reach of children (Fig. 202). He disposes of oily rags and does not use inflammable liquids for dry-cleaning. He keeps the garage doors open while the motor is running, and the windows open in all rooms where gas appliances are burning.

The safety-minded person uses only permanent-type attachments for gas heaters, and does not use flexible tubing. If possible he has outside flues provided for all gas stoves. He has all gas appliances inspected frequently for good condition. He never goes to sleep with a gas stove burning in the room. He uses only the proper fuses in the electric-wiring system. He always disconnects an electric iron or other similar appliance on leaving it even for a few moments (Fig. 203). He would never touch an electrical connection to turn on a light while standing in water, or with wet hands, or while contacting any other metal, particularly plumbing pipes.

The careful person replaces or repairs worn-out electric cords, and does not run them under rugs or under doors where they may



203 Many fires result from electric irons being left connected when the operator leaves for a moment.

become frayed. He never smokes in bed because of the possibilities of falling asleep and setting fire to the bedding or clothing. In lighting gas with a match, he always strikes the match first and has the match flame ready before turning on the gas. He never burns rubbish, trash, or papers near buildings or fences, nor in an open fire, but uses a trash burner or regulation incinerator. He never uses gasoline, kerosene, or other highly inflammable liquids to start a fire.

He keeps all poisons in the medicine cabinet separate from other medicines, or keeps them in specially shaped bottles, or has some other device to designate them. He unloads all firearms before bringing them into the house, and always keeps them out of the reach of children.

The above description of the safety-minded homemaker may sound a bit ideal and unusual, but it represents merely the man who stands a fair chance of avoiding accidents in the home.

Conclusion. Our homes, then, are not really such safe places as we had supposed. Fortunately, however, it requires only a bit of intelligent thought, planning, checking up, and co-operative effort on the part of all family members, young and old, to remake them again into their old form, a "castle of safety."

ACTIVITIES

1. Self-check on your study of this problem. See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. Home-accident records. Prepare a scrapbook of newspaper clippings detailing home accidents in your community over a period of several weeks. Classify (sort) these as to (1) frequency, (2) seriousness, and (3) causes. What can you do to prevent recurrence of these accidents?

3. Your own home accidents. List all the serious accidents that you can recall ever having occurred in your home. Pool the lists for all class members and classify as in Activity 2.

4. Your own home hazards. Make a detailed checkup on your own home. What serious hazards do you find? What will you do to correct each of them?

Home Safety Habits

Check yourself on the following habits. Do you —

a. Keep all rooms and passageways well lighted at night?
b. See that objects are not left on floors where others may stumble over them?
c. Always use a stepladder for reaching high objects?
d. Keep fireplaces screened, matches protected, and hot liquids beyond the reach of children?
e. Keep garage doors wide open while car is warming up?
f. Keep some windows open in rooms where gas stoves are burning, and always turn off gas before going to sleep?
g. Have all poisons in medicine cabinet clearly marked and protected?
h. *Never* touch electrical switches when your body is wet or in contact with metal piping?

SUGGESTED REFERENCES

American Red Cross, *Injuries in the Home and on the Farm*, The American Red Cross, Washington, 1936. (Free.)

National Safety Council, *Safe at Home*, Chicago, 1937.

National Board of Fire Underwriters, *Safeguarding the Nation Against Fire*, New York, the Board, 1940. (Free.)

U. S. Department of Commerce, Accident Prevention Conference, *How to Stop Farm Accidents*, Washington, 1936.

U. S. Department of Commerce, Bureau of Standards, *Safety for the Household*, Government Printing Office, Washington, 1932.

U. S. Department of Commerce, Accident Prevention Conference, *How to Stop Home Accidents*,* Washington, 1936. (Free.)

* For advanced students and teachers.

Problem 30. *How Safe Is Your School?*

STUDY OUTLINE

A. Causes of school accidents
  1. What conditions in school buildings most frequently cause accidents?
  2. What is the chief source of accidents on school grounds?
  3. What kinds of accidents are most likely to occur en route to and from school?
  4. Do school busses have many serious accidents?

B. Discovering school hazards
  1. Can you give good reasons for a school safety-checkup campaign?
  2. What types of items should be checked in school safety surveys?
  3. What are the most common playground hazards?
  4. What are the most common school fire hazards?

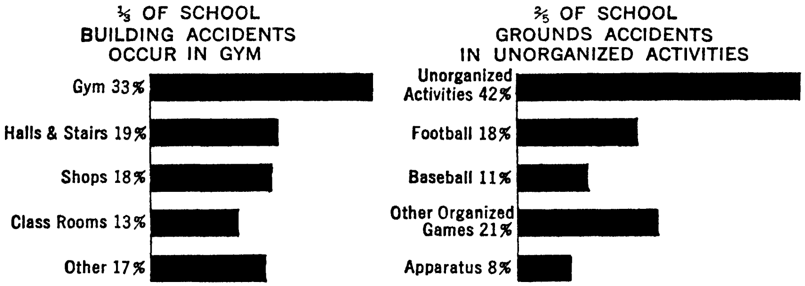
C. Taking steps to increase school safety
  1. What are the chief functions of a school safety council?
  2. How can school safety committees and patrols operate effectively?
  3. How would you go about eliminating school fire hazards?
  4. What are the characteristics of a good fire drill?

D. Training for industrial safety
  1. In what ways can improved safety increase industrial efficiency?
  2. What changes in working conditions would improve school-shop safety?
  3. How can a greater degree of safety consciousness be developed in the school-shop worker?
  4. What are some of the most important safety standards for the school shop?

FORTUNATELY the school is a relatively safe place, and yet not infrequently we read glaring headlines in the papers describing a burning holocaust in which hundreds of children have died a horrible death because someone failed to insist upon adequate protective devices and safe supervision.

CAUSES OF SCHOOL ACCIDENTS

Many of the same types of hazards will be found existing in schools as were described for the home. If a fire starts in a school, however, it may endanger hundreds of lives, where a corresponding fire in a home would affect only a few. Many other types of home hazards occur in the school and menace the life and limb of large numbers.



Source: 1940-41 reports from schools with 866,000 students

204 The gymnasium and playground account for many school accidents. (From *Accident Facts*, courtesy of National Safety Council)

School-building hazards. An average of five serious school fires occurs every day in the United States, fortunately nearly three fourths of them out of school hours. Some schools are fire traps and should be condemned. Such fire traps are caused by inadequate exits and fire escapes, carelessly locked exit doors, failure of panic bolts to operate because of improper adjustment or rust, or improper storage of combustibles.

The custodian or janitor is one of the most important members of the school staff. Frequently, however, he is selected merely as a sweeper and duster, rather than as the custodian of school safety. Obviously, you can't hire a new janitor or build a new building, but you can do much to educate the student body to take proper steps toward eliminating existing hazards.

The gymnasium accounts for approximately one third of all inside accidents (Fig. 204). These may be traceable to poor supervision on the part of instructors, to inadequate or defective equipment, or to carelessness on the part of students. Careless practices include such things as opening doors suddenly while people are

205 Unorganized play activities are the source of many accidents. (Courtesy of Los Angeles Department of Playgrounds and Recreation)

in the halls, and running and shoving in hallways. The classroom and stairway each account for nearly 15 per cent of school accidents. Vocational shops take fourth place in spite of their apparently great hazards.

The eighth and ninth grades appear to be the most hazardous. This may be due to the fact that from the seventh to the tenth grades you were going through a rapid process of development and growth which tended to make you more awkward than formerly. As you get well into adolescence you will become better co-ordinated and be less subject to certain forms of accidents. Therefore during the first two years of high school you should be especially careful to avoid stumbling, falling, and collisions.

School-ground hazards. We have already discussed accidents caused by the most hazardous athletic sports. Other mishaps occur from merely walking or running back and forth across the playground, in climbing trees or fences, riding bicycles, and just fooling. A large percentage of the school-ground accidents, however, occur in informal, unorganized activities (Fig. 205). Elementary-school children suffer more from this source than you do in the high school, since they have fewer organized activities and are usually supervised by teachers with less experience in sports.

Types of accidents occurring on the way to school. The problem of getting to and from school has become greatly complicated with the advent of the automobile, for the motor vehicle is the greatest single risk. Records from various cities show that among the most frequent causes are falls while crossing streets, playing in streets, being transported in autos and school busses, being hit by thrown objects, and riding bicycles.

School busses, some 90,000 of them, transport over 3,000,000 pupils daily. Although these busses together travel over 7,000,000 miles per day, they have had very few serious accidents. Occasional accidents are traceable to defective equipment or to carelessness on the part of drivers. Many states now have rigid laws which should serve to reduce this hazard materially. Monthly inspection of school busses usually is a requirement.

DISCOVERING SCHOOL HAZARDS

In most schools the principal and teaching staff see to it that their students are carefully instructed regarding safe and unsafe practices. Student safety councils and committees, regular fire drills, and safety inspections are of great aid. In other schools, however, such precautions are not taken. An excellent method of developing greater consciousness and interest in safety is to encourage an all-school safety checkup.

A school-safety-checkup campaign. Many home hazards are duplicated in the school; hence much of the material included in the home checkup can similarly be covered in a school inspection. An excellent plan is to have student-body officers call a general assembly, with the approval of the principal, and outline a plan to be followed for the inspection survey. More detailed instructions can be given, if necessary, to the various groups through their home rooms. Friendly competition between home rooms can be developed, with all members of each home room working together to discover all possible accident hazards. Graduated points can be given for the discovery of minor, major, or exceptionally dangerous hazards.

The school safety council may declare the room winner and name one or two students with best individual reports. A simple banner or other type of award can be given to the winning room. Your student group should do the surveying and make the report, with no more than general supervision by the teaching staff. Each home room may be divided, for survey purposes, into several committees to check on different aspects of safety. One committee might be responsible for checking buildings in general, another for shops and laboratories, another for the gymnasiums, and still another for playgrounds.

What to look for. In the items to be inspected include, among others, the following: In buildings, look for broken windows and window catches, protruding nails in floors or walls, broken floor boards, broken blackboards, loose hinges, jagged tile, brick, or cement, loose handrails, faulty panic bolts, locked doors on exit stairways or fire escapes, unprotected radiators, rubbish piles, unlighted stairways, broken stair treads, slippery floors, gas leaks or faulty radiators, unsafe doors, and faulty plumbing and electric connections. Examine fire extinguishers to see if they have been reloaded within a year.

In shops you will check for guards and other protective devices on all kinds of machinery; examine tools, and other equipment to see that they are in good working condition and properly protected; and look for posted lists of regulations and codes governing the operation of machinery.

In the home-economics department you will look for possible hazards about all equipment such as stoves, steam tables, burners, sewing machines, electric irons and ironing boards, kitchen cutlery, can openers, and broken dishes.

On the playground all areas such as horseshoe courts, gymnastic apparatus, swings, and archery ranges should be properly roped or fenced off so that nonparticipants are not exposed to injury. Wet spots, rough spots, irregularities, and holes on the playground surface should be checked; jumping pits should be examined to see that shavings, sawdust, or spaded ground are kept in proper condition. Inspection should disclose any electric wires that might be down, projecting guy wires, water pipes, posts, trees, incinerators, or other objects placed in or projecting into the field of play, that might prove hazardous. Goal posts, baseball backstops, handball courts, and related equipment should be checked for safe condition.

Since fire is one of the greatest hazards faced by the school,

206 Student crossing guards with whistles regulate automobile and pedestrian traffic at school crossings. The street railway company also co-operated by installing a wigway at this crossing.

you will want to include a special fire inspection as part of the general school survey. The National Board of Fire Underwriters has prepared an excellent self-inspection blank for school use.[1] This contains a detailed list of items to be checked.

TAKING STEPS TO INCREASE SCHOOL SAFETY

Modern progressive schools stress the idea that one learns best by doing. Especially in the safety field, well-established habits constitute your best protection. Planning and directing the school-safety program should be done by student officers under the general supervision of one or more faculty members.

A school-safety council. The most successful student safety councils have been those whose work was directed by special officers and committees assigned to that duty alone, rather than by general student-body officers. In most cases the faculty safety committee appointed by the principal serves in an advisory capacity to the student safety council, which consists of a president, vice-president, secretary-treasurer, and usually a representative from each home room or section.

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[1] Copies of this can be secured from the National Board of Fire Underwriters in Chicago, New York, or San Francisco.

The safety council appoints chairmen to be responsible for the several main divisions of the work. These may include committees on school-safety inspection, checkup campaign, assembly, publicity, hall patrol, playground patrol, and first-aid and safety patrol. It is essential that the officers be outstanding leaders in the student body and that the home-room representatives be selected carefully. They should understand that this is an important and responsible position and one calling for the best leadership available.

Members of the several safety committees may be selected either by the chairmen or appointed by the council. The hall-patrol committee usually is charged with full responsibility for plans and regulations governing student traffic in and about the buildings and halls, and for adequate patrolling of these areas. The playground patrol, in addition to supervising the grounds, may also handle street crossings immediately adjacent to the school (Fig. 206). The school-safety committee should make a daily inspection of all buildings and ground areas for potential accident hazards, and submit daily reports to the committee chairman. The patrol and inspection committees must never consider themselves as a police force, but rather as an advisory group.

To a very large extent it is safe to say that the student safety council with its subcommittees can do more than any other agency to reduce serious accidents within the school, the home, and the community in general.

Eliminating fire hazards. School-fire surveys have disclosed that in many cases fire drills are not conducted at all or are very inadequately handled. For example, in some schools fire drills have worked satisfactorily under practice conditions but have been of no value in an actual fire because the exits could not be used. Sometimes the fire escapes themselves were not fireproof, or were so located as not to be accessible to some or all of the students, or ran past open classroom windows making them unusable in case fire broke out in these particular rooms. In other cases windows or doors leading to the fire escapes have been found locked.

Occasionally exit doors were found opening inward instead of outward, so that in case of panic the rush of students would force the doors closed. Not infrequently window or stair approaches to fire escapes have been badly cluttered with books, boxes, and plants so they actually were not usable. Panic bolts on exit doors have even been rusted or otherwise not operating. Often fire extinguishers are missing, or they have not been recharged within a year. Very few schools have the modern automatic sprinkler system, which makes buildings almost 100 per cent safe.

Sound building construction. Incredible as it may seem, many cases of defective fire protection have been found among the supposedly most modern schools. To be sure that your school is safe, plan a school inspection by your student committee at the earliest possible date. Some school buildings have been poorly constructed throughout, not because original plans were not satisfactory, but because some unscrupulous contractor was willing to risk the lives of children for the sake of saving a few dollars in materials.

Your principal or school board can arrange to have your own buildings inspected by the Board of Fire Underwriters or other responsible agents. Often it requires an outsider to check over certain conditions. We may have become so accustomed to deficiencies that they do not catch our attention, even though we might otherwise be sufficiently well informed to recognize the difficulties.

School fire drills. Assuming that your school is well protected from fire and other hazards, it is still important that regular fire drills be conducted periodically. Well-controlled drills doubtless have saved the lives of thousands of school children in the past.

A good fire drill will empty a large building of all students in a short time and without any confusion. The important thing is to prevent excitement and panic. Many students drill well under practice conditions, but lose all control when an actual fire starts. Some schools have, accordingly, instituted so-called obstructed drills. In this plan members of the student body are not informed in advance what parts of the building will be closed off; hence adjustments must be made every time amid changing conditions. They may find a certain exit blocked off supposedly because of fire in that part of the building. The entire plan of procedure may have to be changed and some other exit selected. This surprise element helps them to make adjustments without excitement. The "No Talking" rule should be strictly enforced.

In most systems with good fire-drill procedures, student officers are appointed — usually a fire chief and an assistant, with room captains and room monitors, each assigned specific responsibilities. There may be several monitors to each room, depending on the number of students in the area to be controlled. The room monitors are each assigned two or three windows to close. The room captain takes charge of marching the students out, and closes the door after all have left. He then reports to the assistant fire chief in charge of his floor. Certain monitors are detailed to check on toilet and cloak rooms, and to pick up stragglers. Where there are cripples in a room, a special monitor is assigned to be responsible for them. The checkup roll call should be taken after the pupils from each room have marched a safe distance (at least 100 feet) from the building.

If such a plan of periodic fire drill is maintained regularly, preferably twice a month, it will result in a well-trained student staff who should be able to control their group even in a serious emergency. If you don't have a good fire-drill organization in your school now, why not organize one immediately?

TRAINING FOR INDUSTRIAL SAFETY

One of the most significant aspects of school safety centers around the industrial shop. About two thirds of American wage earners are engaged in some kind of work in connection with industrial products. Hence, it is apparent that a large percentage of high-school graduates will participate in some aspect of industrial work and will be concerned with industrial safety. Future standards in this important field will depend largely upon the manner in which high-school students today are trained in the techniques of shop safety.

Safety and industrial efficiency. Campaigns by such organizations as The National Safety Council, and by industrial leaders themselves, have brought about many improvements in machinery and in conditions surrounding the worker. The National

207 Many occupations, such as structural steel welding, are particularly hazardous.

Safety Council has estimated that since 1913 over a quarter of a million occupational deaths and millions of disabling injuries have thus been prevented.

The encouraging results from the industrial safety movement in the past give good promise for the future. Most employers agreed to participate in the movement only because the accident situation had become so serious that something had to be done. The result was that efficiency was stepped up markedly, partly by savings in accident losses, and partly because the improved conditions encouraged greater production.

Many accidents were traceable to inefficient operation or to defective equipment. Many unsafe conditions were discovered and corrected. These included the encasing of gears and dangerous belts and the placing of various types of guards on moving machinery. Employers began to train workmen to be more careful, and they found that it increased production. Also, the rule would work both ways; namely, that improvement in efficiency would increase safety, and that increase of safety naturally produced greater efficiency.

Industry involves many dangers that are inherent in particular activities. These dangers must be faced by the workman if he is to continue in a given occupation (Fig. 207). Unnecessary hazards, however, should and can be eliminated. In your school-shop work you will want to become expert at recognizing this type of unnecessary hazard and in working out solutions for its elimination. You will also want to develop skills in the handling of machinery so that even the inherent dangers can be greatly reduced.

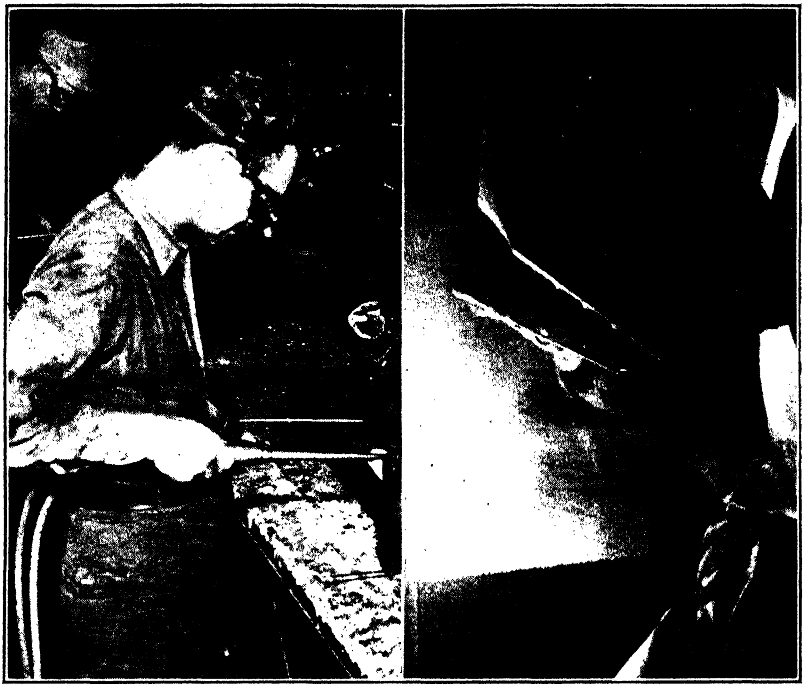
In some cases mechanical safeguards can give you almost automatic protection. In others, only your own ingenuity, quick

208 Every moving part of machinery should be properly guarded. Emery stones, drill presses, and power saws are particularly dangerous. (Courtesy Los Angeles Board of Education)

reaction, and highly developed skills can give you adequate protection. Your instructor will use plans and devices which have been found effective in industry for training you in safety practices, and in all probability your school-shop machinery will be equipped with the most modern safeguards (Figs. 208 and 209). It is possible, however, that there are some points at which the guarding of equipment can be improved, or where better standards of conduct or operating codes can be established. The general shop inspection referred to earlier (page 523) should serve to disclose some of these weaknesses or inadequacies.

Developing safety consciousness and safety habits. Much of the success in accident prevention in industry (Fig. 210) is traceable to definite educational programs for the purpose of training workers to be safety-conscious and observant of accident hazards in and about their work areas. Detailed and systematic accident reports made out with the co-operation of workers has done much to encourage such attitudes. Stress is placed upon the fact that even a minor accident is important because of the possibility of serious infection. Every accident indicates either a weakness in the machinery setup, or a definite failure on the part of the operator.

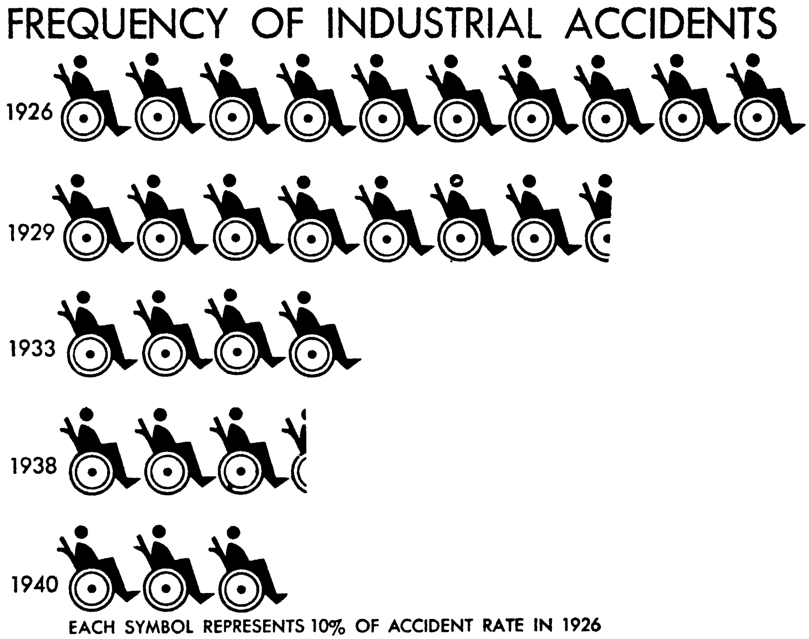
A careful study of safety specifications as outlined by your state



209 Always wear goggles or head protector if the operation is hazardous to eyes or head. Eyes are priceless; goggles are cheap. (Courtesy Los Angeles Board of Education)

industrial accident commission and state compensation insurance fund will help to establish general standards. Many compensation insurance companies also issue detailed safety specifications. The need for emphasis on developing safety consciousness and concern is indicated by the fact that such a large percentage of accidents is traceable to what is commonly called carelessness on the part of the student or worker.

Conclusion. Now that you are familiar with the most common hazards to be found in schools, you will be able to assist in protecting yourself and others from unnecessary dangers that are within your control. You can take part intelligently in a school safety-checkup campaign; you can serve usefully on various safety committees and patrols; you can take part in fire drills with assurance; and in general, you should prove a much more effective member of your student body, at least from the safety standpoint. If through these instructions you help reduce accidents in your community, you will also be a more effective citizen.



PICTOGRAPH CORPORATION

210 The industrial accident rate has been reduced unbelievably since 1926. The 1940 figure is actually less than one third that of the former date.

ACTIVITIES

1. **Self-check on your study of this problem.** See now if you can answer all the questions in the study outline of this problem. Discuss them in class.

2. **Transportation accidents.** Make a special study of accidents that have happened to members of your student body while en route to and from school. Classify them as to school bus, private automobile, bicycle, and pedestrian. What are the greatest hazards? What can you do to prevent their recurrence?

3. **School safety checkup.** Start plans for a complete school safety-checkup campaign under the auspices of the student-body officers. Try to have every student participate in some capacity. Prepare a detailed report for the principal, pointing out the most serious hazards, with possible plans for eliminating them.

4. Safety council. Start plans for the organization of a student safety council, with necessary safety committees and patrols, to carry out the recommendations in Activity 3. This will, of course, require close cooperation with the principal and faculty advisers.

5. Fire drills. Make a special study of fire hazards in your school, and work out several plans for effective fire drills by which the buildings could be emptied quickly. Adapt the plans to situations in which different parts of the building might be cut off by fire or smoke.

School Safety Habits

Check yourself on the following habits. Do you —

a. Avoid running in school class rooms and hallways?
b. Avoid pushing, shoving, and tripping other students?
c. Try to avoid stumbling, falling, and collisions with other players in athletic games?
d. Use great care in going to and from school, to avoid accidents?
e. Avoid scuffling, in school busses, and other actions that might disturb the driver or distract his attention?
f. Conform closely to all directions in school fire drills?
g. Observe all instructions and regulations governing use of machinery and equipment in school shops and laboratories?

SUGGESTED REFERENCES

American Automobile Association, *Standard Rules for the Operation of School Safety Patrols*, Washington, 1937. (Free.)

Henig, Max S., *Safety Education in the Vocational School*,* National Bureau of Casualty and Surety Underwriters, New York, 1928.

LaPorte, Wm. R., Hunt, Chas., and Eastwood, F. R., *Teaching Safety Education in Secondary Schools*,* Prentice-Hall, Inc., New York, 1942.

National Board of Fire Underwriters, *Construction of School Buildings and Improvement of Existing Structures*,* New York, 1937. (Free.)

National Fire Protection Association, *Building Exits Code*,* Boston, 1939.

National Safety Council, *Junior Safety Council Handbook*,* New York, 1935.

—— *School Buses: Their Safe Design and Operation*,* 1938.

—— *Safety Training for Vocational Schools and School Shops*,* 1938.

* For advanced students and teachers.

Problem 31. *Civilian Safety in Wartime*

Cowards die many times before their death;
the valiant never taste of death but once. — SHAKESPEARE

STUDY OUTLINE

A. Maintaining wartime morale
  1. In what main respects does modern war differ from earlier wars?
  2. How can England's air-raid experience help us to maintain morale?

B. Organization for civilian defense
  1. What are the main types of service necessary for civilian defense?
  2. What type of defense organization can schools establish?
  3. What can you as an individual do in defense?

C. How to behave in a blackout
  1. What are the most important steps in training civilians for defense purposes?
  2. What are the most important regulations to observe during blackouts?
  3. What are the main difficulties in effecting a complete blackout?
  4. How can you learn to see clearly in a blackout?
  5. How should a home be blacked out?

D. What to do in an air raid
  1. How can you avoid panic during an air raid?
  2. How should you conduct yourself during an air raid?
  3. What should schools do if a raid occurs during school hours?
  4. What are the most important procedures in handling incendiary bombs?
  5. How would you deal with poison gas?

MODERN warfare has placed civilians on the spot. The airplane bomber has made it impossible for the best trained army and navy to protect homes adequately against enemy assault.

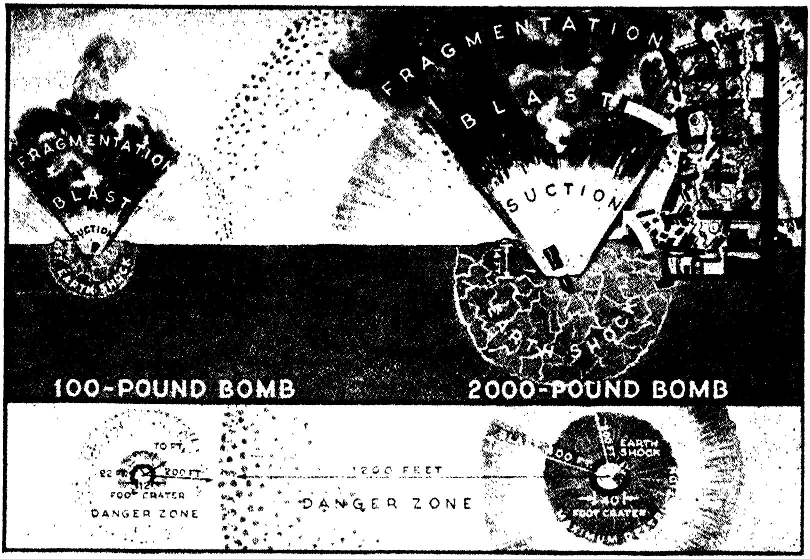
In the First World War, the action was chiefly on the "battle front." The airplane had been developed to the point where some bombing was done, but on a relatively small scale. Germany at that time made approximately 100 air raids on England and is claimed to have dropped a total of 270 tons of bombs, killing an estimated 1,400 persons. In the Second World War, however, an air force of 20 squadrons drops twice that number of bombs within a few moments.

This creates a condition where every home and industry, every communication line and other activity, no matter how far from the battle front, is subject to the constant threat of bombing. This calls for universal training of civilians for home defense, for the protection of production resources, factories, mills, oil reserves, and munitions works.

MAINTAINING WARTIME MORALE

Total war contemplates direct attack on civilian life and institutions for the purpose of undermining confidence, instilling fear, breaking down national morale, and disrupting all civilian support of defending military forces. Total war in the hands of dictator leaders stops at nothing; hence, everything possible must be done to counteract their efforts.

The importance of morale. It has been said that good morale is as important to public defense as guns and planes. Our national problem is to maintain confidence and self-assurance on the part of every individual. In America we treasure freedom of thought and action. We dislike propaganda. We want truth and frankness. We must, however, be prepared to fight the insidious propaganda encouraged by dictator countries through so-called fifth-column activities. Enemies within can be expected to do everything possible to discredit our government, our army, our navy, and our civilian leadership. Both irresponsible gossip and malicious tongues can do untold damage to our national solidarity. It is a good policy to believe nothing and pass on nothing that is not supported by official reports and objective evidence. Spike all rumors! Have faith in your government and the defending forces. If you must become frightened, don't let anybody know it. Avoid hysteria and panic. Maintain a bold front, as every American can do.



211 Fragmentation bombs explode with terrific force and noise. The combined earth shock and air suction of a 2,000-pound bomb will destroy complete buildings, and will hurl fragments over a 1,200-foot radius. Even a 100-pound bomb will throw fragments 200 feet. (Courtesy of *Life* magazine)

England's example. England demonstrated how to carry on her work, in spite of continuous air raids. Month after month, millions of English people were forced to listen to the hair-raising wailings of air-raid sirens, the rumble and crash of anti-aircraft guns, the whining drone of enemy bombers, and the shriek of descending bombs with their blinding, deafening explosions (Fig. 211). In spite of all this, however, they maintained an outward calm and carried on their daily activities with optimism and joviality, taking the war in stride.

Keeping in good physical condition. Authorities agree that one of the most important factors in morale is keeping in good condition. Watch your diet; get plenty of sleep; exercise regularly; and take time out for recreation.

ORGANIZING FOR CIVILIAN DEFENSE

National defense is both active and passive. *Active* defense has to do primarily with the functions of the armed forces — the army, navy, and aviation units. *Passive* defense has to do with community preparation for emergency measures in case of attack, and for the long-range preparation necessary to maintain essential industries and education. We are concerned in this problem primarily with community defense preparation.

General defense organization. On May 20, 1941, the United States Office of Civilian Defense was established by the Government as a voluntary-civilian-defense program. Mayor Fiorella H. LaGuardia, of New York City, was appointed as United States Director of Civilian Defense. LaGuardia explains the functions of civilian defense as of two types: first, to prepare communities for attack; second, to better the health, economic security, and well-being of our people in order to make our country strong.

Civilian defense then concerns itself first with problems of air-raid warnings, provision of bomb shelters, medical care, sanitation, fire protection, and innumerable other aspects of volunteer service in civilian protection. In the second place, it seeks to solve long-range problems of public-health service, educational and recreational opportunities, adequate housing, training of defense-production workers, and social-welfare work.

Under the National Council are organized state, county, and city defense councils, whose work usually is classified under seven main headings:

1. *Civil protection.* The maintenance of law and order, adequate police patrol, guarding of civil liberties, and the enlistment and training of volunteer workers.

2. *Property protection.* Flood control, fire prevention and fire warnings, police protection, and other major-disaster functions.

3. *Health, welfare, and consumer interests.* First aid, home nursing, hospitalization, public recreation, conservation of foods and commodities, and general education.

4. *Public works, housing, and transportation.* The provision of adequate housing, highway construction, electric-power and water service, airport and harbor facilities, and the planning and building of air-raid shelters (Fig. 212).

5. *Human resources and skills.* The mobilization of technical and professional services of all types, rehabilitation work, and the problems of labor and capital. Adjustments must be made between

212 Among other things the shelter room should contain candy bars, a hot drink or soup, candles and matches, flashlight, reading and game materials, and a first-aid kit, including gauze bandages, tape, iodine, burn ointment, ammonia inhalants, and a pair of small scissors. (Acme)

labor and capital so that strikes may be avoided in all essential industries.

6. *Industrial resources and production.* The conservation of natural resources, and the production, storage, and distribution of essential commodities and war materials.

7. *Morale and public relations.* The promotion of educational programs and publicity, the maintenance of speakers' bureaus, and the control of sabotage. The latter alone is a tremendous problem in war times, particularly in a democratic country. This must be handled largely by local law-enforcing bodies with the assistance of the Federal Bureau of Investigation. Guards must be provided for munitions plants, public-utility and power lines, communication centers, oil resources, dams and reservoirs, and even national forests as water sheds.

Emergency defense-service organization. The combat, or emergency phase, of the defense service is concerned primarily with providing protection against air raids. This is customarily divided into seven major divisions or services:

1. *Headquarters* consists of an administrative and co-ordinating staff with large numbers of volunteer assistants as drivers and messengers. Often high-school boys and girls are used for this purpose.

2. *Air-raid wardens* are appointed for fixed areas. They, with their assistants, work on emergency problems of food and housing; notify headquarters of needed services; and maintain watchers to spot incendiary and explosive bombs and fires.

3. *Fire service* is headed by the fire department with many volunteer assistants. It also operates rescue squads.

4. *Police service* uses both regular and volunteer police, together with emergency bomb squads.

5. *Medical service* includes the use of community physicians, hospitals, nurses' aids, medical assistants, and sanitation squads.

6. *Public-works service* maintains "demolition" squads to tear down dangerous walls and buildings following bomb explosions; repair squads to make necessary repairs on buildings and equipment; and "decontamination" squads to take care of areas and persons affected by mustard or other poison gases.

7. *Utility service* maintains and repairs telephone service, municipal signal systems, radios, light and power, water service, and public air-raid and blackout warning systems.

The above outline will give you some conception of the elaborate system of defense services necessary to protect a community and its people against possible air raids. It involves a great deal of volunteer service and close co-operation of all persons concerned.

Institutional defense plans. Most schools and colleges have found it advisable to set up their own defense organization for protection in case of raids while school is in progress. The plan established at the University of Southern California illustrates one such organization. It consists of a general chairman (the President of the University) with two aides and a co-ordinating committee of three to direct the activities of eleven subcommittees responsible for the following duties:

1. *Air raid.* To organize and assign duties to students and faculty in the event of an air raid and to issue instructions as to what to do.

2. *Fire.* To survey available fire-fighting equipment and to secure installation of equipment where it is lacking, to organize and instruct squads of student and faculty volunteers to deal with campus fires.

3. *U.S.O. co-operation — entertainment.* To organize entertainment committees to answer U.S.O. (United Service Organization) requests for help, and to arrange social events for men in uniform.

4. *U.S.O. co-operation — recreation.* To sponsor an expanded program of sports and recreational events, and to train recreational leaders for on- and off-campus activities.

5. *Red Cross first aid.* To organize and conduct first-aid and home-nursing courses, to organize squads of trained personnel to administer first aid when needed.

6. *Morale.* To keep the student body informed on civilian-defense developments, to clarify misunderstandings, to enlist the aid of students in writing or speaking in behalf of the defense program.

7. *Student counseling.* To advise students on individual problems relative to enlistment and participation in defense efforts.

8. *Temporary housing.* To survey campus and general community, and prepare lists of available rooms for emergency housing.

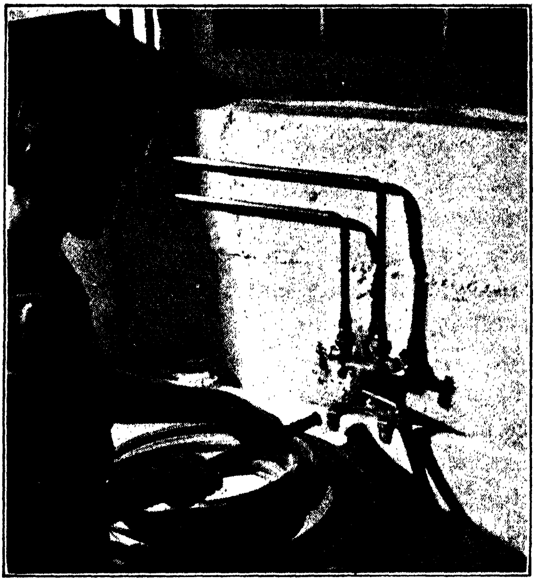
9. *Foreign-student relations.* To maintain friendly co-operation between native Americans and foreign students, and to encourage international social functions.

10. *Student research.* To investigate and stimulate research through institutional facilities on national-defense projects.

11. *Information.* To serve as a clearinghouse for defense information.

What the individual can do. Naturally, your first reaction as you read over these many defense activities is likely to be, "What can I as a high-school student do to help?" A wide variety of activities is available from which you may choose.

You can promote the sale of defense bonds and stamps, and can aid in salvaging essential materials for war purposes. You can speak before school meetings to promote democratic loyalty and interpret national and international problems, particularly meetings which will bring persons of different nationalities together for mutual understanding. You can lead or participate in discussions of current events, citizenship problems, and defense activities. You can act as community-playground assistant, leading active and quiet games, telling stories, assisting with athletic sports. You can lead or instruct groups in those activities for which you are qualified, such as arts, crafts, dramatics, and music.



213 The auxiliary fireman, at home and at school, will see that all fire-fighting apparatus is in good condition, and that garden hose with spray nozzle is kept attached ready for instant use. (Acme)

Boys can volunteer as assistant air-raid wardens, messengers, firewatchers, auxiliary firemen (Fig. 213), or as first-aid assistants in the medical corps. Girls can participate in Red Cross activities such as sewing and knitting; can take first-aid and home-nursing courses; and can assist in entertaining children on playgrounds and in group organizations. They can assist in collecting book and magazine libraries for camp and community centers, and in directing recreation programs in U.S.O. buildings and centers. In defense offices they can give volunteer clerical assistance, help in filing and in preparing statistical reports and publicity. Many other opportunities for service will present themselves in your particular community.

Register for volunteer service with the police department, fire department, or other central registration area, and you will be assigned to duties according to your training and best abilities. Special training courses are usually given for the technical aspects of civilian service. Air-raid and fire wardens are given instructions regarding their many duties; volunteer police are trained in handling non-cooperative citizens; and first-aid assistants receive Red Cross training.

HOW TO BEHAVE IN A BLACKOUT

The term "blackout" is an outgrowth of modern bombing warfare. Since squadrons of war planes are too easily detected in full daylight, they usually fly over their objectives at night. Since brilliantly illuminated cities make ideal targets for enemy planes, it has been necessary to devise some scheme for blotting out *all* light sources. Even a few lights may direct the enemy to his target. It is surprising how far one tiny ray of light will carry on a dark night. The co-operation of everyone, young and old, is required to attain a *complete* blackout in a community.

Educating and training civilians for defense. Experience shows that most preliminary or trial blackouts in communities are far from successful. Some people consider the blackout foolish and unnecessary; others do it in a half-hearted way; some try but are inefficient; and others simply refuse to co-operate. Blacking out public buildings, factories, streets, and even homes, requires a great deal of ingenuity, patience, hard work, and one hundred per cent co-operation. If a few do not co-operate, they jeopardize the safety of all.

In many communities mob riots, and near-gangsterism have developed, in which windows and neon lights in stores have been smashed because the owners failed to turn out their lights. Obviously such violence is neither democratic nor safe. In America we do not believe in mob rule. There is also a great fire hazard in the breaking of neon signs, and a big fire would make an ideal beacon for attacking planes. When neon tubes are broken, the circuit is opened and the high voltage charge can produce an electric arc ½ inch or more in length. This may readily ignite the sign and the entire building. To prevent such developments most communities require installation of outside switches accessible to air-raid wardens.

Because of the failure of some people to co-operate, it has been necessary for local authorities in most communities to pass blackout ordinances carrying penalties, usually a six-months' jail sentence, or $500 fine, or both, for failure to conform to blackout regulations. In addition to usual regulations it seems necessary to specify that it is a misdemeanor for any unauthorized person to operate a siren or other audible device in such manner as to simulate a blackout, or all-clear signal.

The most effective means, however, of securing adequate blackouts is through (1) educating every man, woman, and child concerning just what to do and how to do it; and (2) planning a well-organized volunteer service of air wardens and messengers who quickly notify everyone in the community whose lights show after a blackout signal has been given. Most people co-operate willingly because they know that their safety depends upon it.

Regulations and procedures for blackouts. Regulations differ somewhat in different communities, but the usual form of signal system is as follows:

The *blackout signal* is a two- to five-minute blast on a fluctuating or undulating pitch. These signals are given on large sirens similar to the ones used for fire signals in many cities.

The *all-clear signal* consists of one long steady blast (sometimes interrupted by staccato) of the siren, usually for one minute.

When the *blackout signal* is sounded, you must do the following things immediately:

1. Get in a building and stay there. By all means don't go into the street and do not even step outside the house or open a door where light might show.

2. If at home, extinguish all lights that can be seen from out of doors, or cover windows completely so that no glare, not even a tiny crack of light, will be observable outside.

3. If driving an automobile, extinguish all lights immediately. Red stop lights or others that operate automatically should be covered. Practices vary as to whether cars may proceed during a blackout. In some communities the regulation is that they must pull to the curb and remain there with lights extinguished until the all-clear signal sounds. In other communities, they are permitted to proceed cautiously at 5 miles per hour without lights; but obviously this is very dangerous, and many serious accidents have occurred as a result of it. In still others, cars are permitted to proceed at limited speeds provided the headlights are treated in a prescribed manner to reduce the illumination very markedly. You will naturally observe the regulations established for your own community.

4. The use of flashlights, or other forms of intermittent light out of doors, where they will be visible from above, is usually prohibited.

5. All stores, offices, factories, and other places of business must extinguish exterior lights and be sure that interior lights, if left on, do not show outside.

6. Automobilists or pedestrians, if not near home, should seek safety in the nearest air-raid shelter or other building. Pedestrians should wear light clothing or carry something white to help avoid collisions with others. It is not safe to cross streets or to walk in streets, as the accident record in blackouts has been exceedingly high.

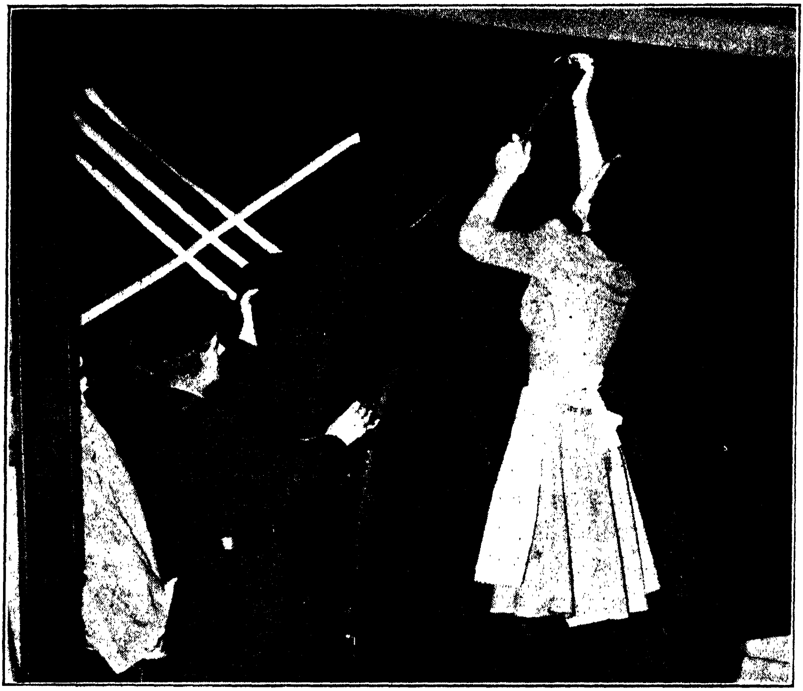
In most cases, street crossing signal lights are painted so as to give a tiny cross of light instead of the full illumination. Street lights and illuminated signs of all kinds are turned off. The objective is to produce inky darkness in the entire community.

Blackout problems. You will not find it an easy thing to effect a complete blackout, even in your home. Select one or two rooms, preferably the kitchen, for complete blackout. In porches, garages, and rooms that cannot be darkened, it is wise to remove the electric-light bulbs so that lights cannot be turned on accidentally.

Blackout materials for windows should be very dark, and heavy enough not to transmit light. If you cannot secure such materials, hang heavy blankets or rugs over the windows (Fig. 214). Heavy cardboard or wallboard is effective if fitted closely enough to prevent cracks of light from showing. Black roofing paper tacked to frames that can be fitted tightly into window areas is serviceable, but may be easily torn or broken. One of the blacked-out rooms should be the safest in the house from the standpoint of bomb explosions; namely, it should have few or small windows and be as near the center of the house as possible.

In some cases, electric power may be turned off; hence it is well to have auxiliary light sources such as candles, flashlights, lanterns, or lamps that can be used in emergency. When blackouts are imminent, it is also advisable to carry a tiny pocket flashlight for use in emergencies.

How to see in a blackout. After being in the dark for a while, you will be surprised at how well you can see. Your vision will

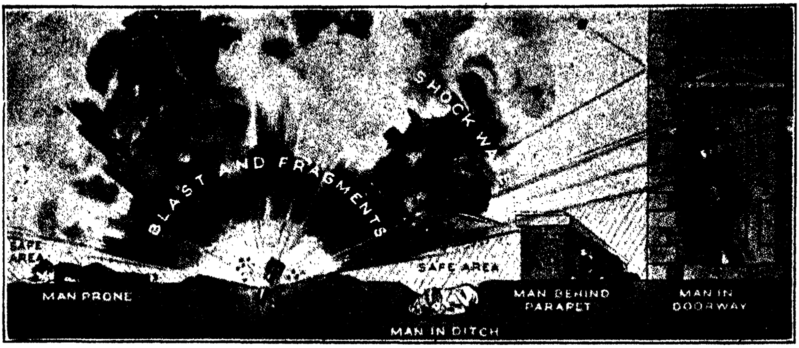


214 Taping windows with adhesive reduces the hazard of flying glass, and *heavy* blackout curtains serve the same purpose. (Acme)

be much more effective, however, if you do not look directly at dim objects. If you will focus the eyes slightly to one side of the object, you will get a much clearer view of it. Vision in the dark is effected by the *rods* which are located in the outer area of the retina of the eye, while daylight seeing is accomplished through the *cones* in the center of the retina (see page 304).

WHAT TO DO IN AN AIR RAID

With proper planning and the full co-operation of all citizens in a community, the hazards from air raids can be materially reduced. It is essential to: (1) avoid hysteria and panic — keep calm; (2) be informed on what procedures to follow at all times; (3) perfect plans for complete blackouts in case of a threatened air raid; (4) know how, quickly, to reach an air-raid shelter or safe spot in the home or other building (keep door unlocked and passage clear);



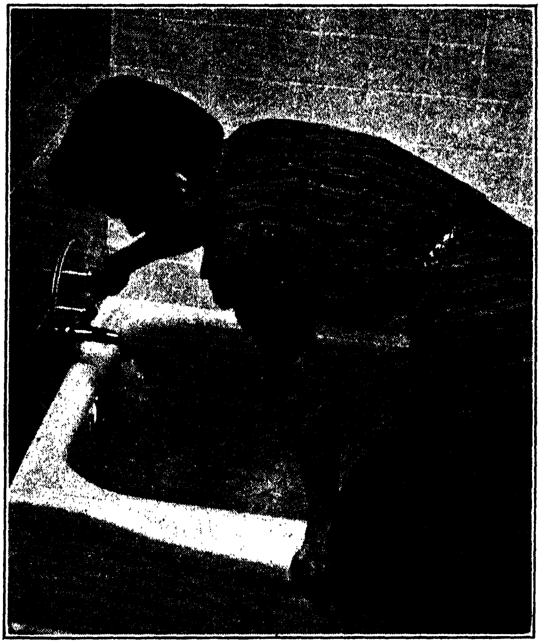
215 Even a 100-pound bomb is dangerous to anyone standing within 200 feet. In the open, the safest places are behind concrete walls, in ditches or hollows, or at least lying flat on the ground. (Courtesy of *Life* magazine)

(5) know how to act if caught in the open, to reduce probability of bomb injury; (6) know how to handle incendiary bombs; (7) become increasingly expert in doing the particular task assigned to you in air-raid protection.

General principles of conduct in air raids. In case of actual bombardment neither you nor your home is likely to be struck directly by a bomb. The great danger is from splinters and fragments of exploding bombs and anti-aircraft shells (Fig. 215). Bomb action is chiefly lateral and slightly upward, hence, the best protection is below ground level if possible (except in gas attacks). If caught in the open or if you hear a bomb coming, lie down in a ditch or hollow. Even a shallow ditch gives some protection.

If you are in a building, get into the innermost room farthest from outside windows and doors. Get near corners of rooms where there is least danger from falling ceiling or flying glass. Windows should be open from the top, and blinds closed. Adhesive tape or heavy paper strips pasted on window glass helps to prevent splintering. Fine-mesh wire or blankets hung over windows inside will also help. If a bomb is likely to burst near you, bite something between the teeth, preferably a thick piece of rubber, to keep the mouth open and thus maintain equal air pressure on the eardrums. This reduces the probability of rupturing them.

Air-raid rules. A few simple rules may help in case you face an actual air-raid bombardment:



216 Some authorities recommend filling the bathtub with water during a raid. However, if everyone in the community fills bathtubs at the same time, there is a danger that the local water pressure will be reduced. Consult your own air-raid warden about this. (Acme)

1. Most important, maintain self-discipline and self-control. You can do much to help others and avoid panic by remaining calm yourself. Don't let yourself go to pieces or blow up nervously. Losses from panic are very heavy because people lose control and do the wrong thing.

2. As a rule, stay where you are if a raid starts, seeking the best immediate cover available.

3. Do not run into the street; danger from flying splinters and falling masonry is greatest there. Stay under cover until the danger is over.

4. If you are on the street when the air-raid signal sounds, and no air-raid shelter is available, go into the nearest building, house, or other sheltered area.

5. If you are in an automobile, pull over to the curb and park the car, taking care not to leave it in an intersection, in front of a fire plug, or emergency entrance. If necessary, park "double," but be sure there is space in the middle of the street for emergency vehicles to get through. Do not stay in the car. It is hazardous because of the glass. If you cannot reach cover, lie down in a low spot. Statistics indicate that the chances of being struck when standing are twice as great as when lying down.

6. If you are inside a building or home, keep away from windows, doors, and other openings including outside hallways.

7. Do not use the telephone unless absolutely essential, so as to keep lines free for emergency calls. Keep your radio turned on for information on what to do.

8. In case of fire, report it to the fire department, but try to put it out yourself if possible. Keep handy a long-handled shovel, buckets or boxes of dry sand or earth, and a ladder long enough to reach the roof. Keep a garden hose always attached to a faucet (Fig. 216).

9. If you find an incendiary bomb, try to shovel it into the street or open place where it will not be near inflammable materials, and cover it with dry sand or dirt.

School air-raid procedures. In case an air raid should develop while school is in session, keep *quiet* and *calm* so that you may hear and follow instructions from your school principal and teachers. Usually they are advised not to permit pupils to leave the building or to attempt to go home. They also urge the parents not to come to the school since they would only accomplish harm by jamming the highways and taking children out of the relatively safe refuge of the school.

School fire-drill organizations are used to get pupils to the air-raid refuge. This will usually be a large inside hall, or other central area removed from outside windows. Each class and instructor should be assigned a specific space in the refuge, and detailed instructions should be given as to what each is to do in case of a raid. Alternate refuges should be agreed upon in case the others might become inaccessible. Fire squads with a fire chief usually are appointed to take charge of emergency work in handling incendiary bombs or actual fires. Frequent air-raid drills should be conducted so that students will know just what to do, and to assure good morale.

How to handle incendiary bombs. Incendiary bombs are dropped by enemy planes for the purpose of starting extensive fires. They are made of magnesium, with an igniting mixture on the inside; are usually about 14 inches long and 2 inches in diameter; and weigh a little over 2 pounds. When these bombs fall outside of buildings, they should be covered with sand and the authorities notified at once. If they strike on your roof or inside the building, particularly in the garret, the most difficult problem is to reach

217 Use only a fine spray of water to wet the bomb and the surrounding area. By proper spraying, the burning period can be reduced from 15 minutes to 3 or 4 minutes. (Photo by Alan Fisher, *PM*)

them; hence, ready access should be available to any boxed-in areas on the upper floors. Be sure rubbish is cleaned out of attics. The following implements for handling bombs should always be available: a long-handled shovel, hoe, axe, a metal container such as a garbage can, a supply of dry sand, and a flashlight or other means of illumination.

A burning bomb within a house is most effectively handled through the principle of smothering and cooling. Water spray from a garden hose (not a jet) is effective (Fig. 217); first, because the spray in contact with the burning metal is converted into steam thus producing a cooling effect; second, the burning time of the bomb may thus be reduced; third, the floor and surrounding areas can be cooled, thus helping to prevent the spread of the fire. If water spray is not available, a metal container (garbage can) with a 4-inch layer of sand on the bottom can be used to attempt to carry the burning bomb from the building. Use shovel and hoe to place the bomb in the container, and cover with layer of sand.

Precautions. (1) Do not approach within 50 feet of a burning incendiary bomb during the first full minute after it ignites; (2) do

218 *No! Don't do it!* A solid jet of water may cause the bomb to explode. A bucket of water thrown on it is just as bad. (Photo by Alan Fisher, *PM*)

not direct a solid stream of water against the bomb as *this will cause a minor explosion* (Fig. 218); (3) do not allow the fire to get beyond control — neglect the bomb if necessary to prevent spread of fire through the house; (4) avoid exposure to the bomb — protect yourself by a screen, an overturned table, or other device; (5) be sure to have an avenue of escape from the burning area.

What to do with poison gas. Poison gases come in both liquid and gaseous forms. They may be sprayed from airplanes or dropped in bombs, which burst as they strike. *Most poison gases are relatively easy to detect by odor before they can do much damage.* They are not likely to cause immediate death, but do produce skin burns and irritate the lungs.

General gas-raid precautions are as follows: (1) In case poison gas is suspected, telephone the nearest fire station; (2) close all windows and doors, put out fires, stop up door and window cracks and fireplaces, turn off ventilating and heating units if any; (3) if you are in the open, choose high points of ground and get on the windward side of fallen bombs if possible; (4) do not leave the building in which you are located unless it is hit directly by a gas bomb; (5) avoid contamination by contact with persons or places that have already been affected by mustard or other form of gases.

Conclusion. It is to be hoped that America will never have to face the horrors of extensive enemy bombing. Since, however, anything can happen in a war with unscrupulous opponents, it pays to be prepared. The preceding information on the organization of civilian defense and what to do in blackouts and air raids should give you sufficient information so that you can protect yourself reasonably well and also be of great help to others.

ACTIVITIES

1. **Self-check on your study of this problem.** See now if you can answer all the questions in the study outline of this problem. Discuss them in class.
2. **School organization for civilian defense.** If your school is not already organized for civilian defense purposes, work out the details for such an organization. If it is organized, scrutinize the plan carefully to see if there are points at which it might be improved.
3. **Blackout procedure.** If your community has not experienced a blackout, work out the details of how you would black out your own home successfully. Experiment with several devices for darkening windows.
4. **School air-raid defense.** If your school has not conducted air-raid drills, plan a program whereby all students could be gotten to the safest areas in your school building, using fire-drill technique and organization. Perhaps the principal can be persuaded to have an actual air-raid drill.

REFERENCES

Architectural Forum, November, 1940, pp. 409–436.

Glover, C. W., *Civil Defense*, Chapman and Hall, Ltd., London, 3d ed., 1941.

Statutory Rules and Orders, *Your Home as an Air-Raid Shelter*, His Majesty's Stationery Office, London, 1940.

United States Office of Civilian Defense, *Blackouts*, 1941 (and other pamphlets), Washington, D.C.

War Department, Civilian Defense, *Protection Construction*, Bull. 1, Washington, D.C., 1941.

Appendix

GENERAL REFERENCES

References dealing with particular subjects are listed at the end of each problem. Those listed here are useful in connection with many problems of this book.

Amberson, Wm. R., and Smith, D. C., *Outline of Physiology*, Williams & Wilkins, Baltimore, 1939.

Andress, J. M., Aldinger, A. K., and Goldberger, I. H., *Health Essentials*, Ginn and Company, Boston, 1928.

Bauer, Wm. W., *Health, Hygiene, and Hooey*, Bobbs-Merrill Company, Indianapolis, 1938.

Best, C. H., and Taylor, N. B., *The Human Body and Its Functions*, Henry Holt & Co., New York, 1932.

Blount, R. E., *The Science of Every Day Health*, Allyn & Bacon, Boston, 1936.

Burkard, Wm. E., Chambers, R. L., and Maroney, F. W., *Health and Human Welfare*, Lyons and Carnahan, New York, 1937.

Bush, Geo. L., Allan, D., and Runkle, R. C., *A Biology of Familiar Things*, American Book Co., New York, 1939.

Carlson, A. J., and Johnson, V., *The Machinery of the Body*, University of Chicago Press, Chicago, 1941.

Clendening, Logan, *Common Sense Health Chats*, Blue Ribbon Books, New York, 1939.

Clendening, Logan, *Human Body*, Alfred A. Knopf, New York, 3d ed., rev., 1941.

Cobb, Walter F., *Health for Body and Mind*, D. Appleton-Century Co., New York, 1941.

Cockefair, Edgar A., and Cockefair, A. M., *Health and Achievement*, Ginn and Company, Boston, 1940.

Corwin, Mae, and Corwin, Walling, *The Science of Human Living*, Harr Wagner, San Francisco, 1937.

Crisp, Katharine B., *Be Healthy*, J. B. Lippincott Company, Chicago, 1938.

Diehl, Harold, *Healthful Living*, McGraw-Hill Book Co., New York, new rev. ed., 1941.

Fisher, Irving, and Emerson, H., *How to Live*, Funk & Wagnalls Co., New York, 20th ed., 1938.

Graubard, M. A., *Biology and Human Behavior*, Tomorrow, Publishers, New York, 1936.

Haggard, H. W., *Science of Health and Disease*, Harper & Brothers, New York, 1938.

Hunter, Geo. W., *Life Science, A Social Biology*, American Book Co., New York, 1941.

Kimber, Diana C., Gray, C. E., and Stackpole, C. E., *Textbook of Anatomy and Physiology*,* The Macmillan Company, New York, 10th ed., rev., 1938.

Kirkpatrick, Thomas B., Heuttner, A. F., and Taylor, C. M., *Fundamentals of Health: The Human Organism, Its Development and Conservation*,* Ginn and Company, Boston, rev. ed., 1941.

Meredith, Florence L., *The Health of Youth*, P. Blakiston's Son & Company, Philadelphia, 1928.

Meredith, Florence L., *Hygiene*, P. Blakiston's Son & Company, Philadelphia, 3d ed., 1941.

Rathbone, Josephine L., Bacon, F. L., and Keene, C. H., *Foundations of Health*, Houghton Mifflin Company, Boston, 1936.

Sherbon, Florence B., *The Family in Health and in Illness*, McGraw-Hill Book Co., New York, 1937.

Smith, Ella T., *Exploring Biology*, Harcourt, Brace and Company, New York, 1939.

Stiles, Percy G., *Human Physiology*,* W. B. Saunders Company, Philadelphia, 8th ed., rev., 1939.

Wheat, Frank M., and Fitzpatrick, E. T., *Everyday Problems in Health*, American Book Company, New York, 1935.

Williams, Jesse F., *Healthful Living*, The Macmillan Company, New York, 3d rev. ed., 1941.

Williams, Jesse F., *Personal Hygiene Applied*,* W. B. Saunders Company, Philadelphia, 7th ed., rev., 1941.

Wood, Thomas D., and Rowell, H. G., *Health Through Prevention and Control of Diseases*, World Book Company, Yonkers, 1925.

SPECIAL GUIDES FOR TEACHERS

Blount, R. E., *Handbook for the Use of Teachers Conducting Classes in Health*, Allyn & Bacon, Boston, 1930.

Weber, Lynda M., *Functional Health Teaching Syllabus*, Ginn and Company, Boston, 1941. (Excellent up-to-date aid for teachers.)

REFERENCES ON HISTORY OF HEALTH SCIENCE

Broadhurst, Jean, and Lerrigo, M. O., *Health Horizons, Contributions to Health Teaching from History and Science*, Silver, Burdett, & Company, New York, 1931.

De Kruif, Paul, *Men Against Death*, Harcourt, Brace and Company, New York, 1932.

De Kruif, Paul, *Microbe Hunters*, Harcourt, Brace and Company, New York, 1926.

Hallock, Grace T., and Turner, C. E., *Health Heroes*, Metropolitan Life Insurance Company, New York. (Pamphlets, biographical sketches.)

Holway, Hope, *The Story of Health*, Harper and Brothers, New York, 1931.

Winslow, C. E. A., and Hallock, G. T., *Health Through the Ages*, Metropolitan Life Insurance Company, New York, 1933.

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* For advanced pupils and teachers.

LABORATORY MANUALS AND WORKBOOKS

Baker, Arthur O., and Mills, Lewis H., *Activities for Dynamic Biology*, Rand McNally & Company, New York, 1938.

Blount, R. E., *Laboratory Guide and Pupil's Note-book for the Study of Health*, Allyn and Bacon, Boston, new ed., 1930.

Bush, G. L., and others, *Activities to Accompany a Biology of Familiar Things*, American Book Co., New York, 1939.

Cook, S. F., and Burmeister, M. A., *Laboratory Manual in Human Physiology*, Harper & Brothers, New York, 1935.

Curtis, Francis D., and Sherman, N. H., *Workbook, Everyday Biology*, Ginn and Company, Boston, 1940.

Harvey, E. N., and Parport, A. K., *Laboratory Directions in General Physiology*, Henry Holt & Company, New York, 3d rev. ed., 1933.

Haupt, A. W., *Laboratory Directions for General Biology*, McGraw-Hill Book Co., 3d ed., 1940.

Kinsey, A. C., *Workbook in Biology*, J. P. Lippincott Company, Chicago, 1937.

Weckstein, A. M, and Poster, E., *Directed Activities in Biology*, Oxford Book Company, New York, 1941.

Wootten, Kathleen W., *A Health Education Workbook*, A. S. Barnes, New York, 1936.

CONSUMER EDUCATION

American Medical Association, *Patent Medicines*, The American Medical Association, Chicago. (Pamphlet.)

Chase, Stuart, and Schlink, F. L., *Your Money's Worth*, The Macmillan Company, New York, 1928.

Consumers' Counsel, Agricultural Adjustment Administration, Department of Agriculture, Washington, D. C.

Consumers' Research (Yearbook and Bulletins), Washington, New Jersey.

Consumers' Union of the United States, Philadelphia.

Hambridge, Gove, *Your Meals and Your Money*, McGraw-Hill Book Co., New York, 1934.

Kallet, Arthur, *Counterfeit — Not Your Money but What It Buys*, The Vanguard Press, New York, 1935.

Mitchel and Cook, *Facts, Fads and Frauds in Nutrition*, Bulletin No. 342, Massachusetts State College, Amherst, Mass.

Vincent, W. W., *How to Read the Label*, Pure Food and Drug Bureau, Washington, D. C.

ORGANIZATIONS PUBLISHING PAMPHLETS, BULLETINS, AND MAGAZINES

Magazines, only, are mentioned specifically. Write to organizations for list of publications.

American Business Men's Research Foundation (alcohol), 7 South Dearborn Street, Chicago.

American Dental Association, 212 East Superior Street, Chicago.

American Heart Association, 50 West 50th St., New York.

American Hospital Association, Inc., 18 East Division St., Chicago.

American Journal of Public Health, 50 West 50th Street, New York.

American Medical Association, 535 North Dearborn Street, Chicago. (*Hygeia.*)

American Public Health Association, 50 West 50th Street, New York.

American Red Cross, Seventh and D Streets, Washington, D. C.

American Society for the Control of Cancer, 1250 Sixth Avenue, New York. (Bulletin, monthly.)

Anti-cigarette League, 58 West Washington Street, Chicago.

Better Vision Institute, 205 East 42d St., New York.

California Fruit Growers' Exchange, Los Angeles.

Child Welfare League of America, 130 East 22d Street, New York.

Dairymen's League Cooperative Association, 11 West 42d Street, New York.

Foundation for Narcotic Research and Information, 150 Fifth Avenue, New York.

Good Teeth Council for Children, 400 North Michigan Avenue, Chicago.

International Narcotic Education Association, 578 Madison Avenue, New York.

John Hancock Life Insurance Company, St. James Ave., Boston.

Metropolitan Life Insurance Company, 1 Madison Avenue, New York.

National Child Labor Committee, 419 Fourth Avenue, New York.

National Committee for Mental Hygiene, 50 West 50th Street, New York. (*Mental Hygiene.*)

National Education Association, 1201 16th Street, N.W., Washington, D. C.

National Food Bureau, 309 W. Jackson Boulevard, Chicago.

National Health Council, 50 West 50th Street, New York.

National Safety Council, 20 North Wacker Drive, Chicago.

National Society for the Prevention of Blindness, 50 West 50th Street, New York.

National Tuberculosis Association, 50 West 50th Street, New York.

Scientific Temperance Federation, 400 Boylston Street, Boston.

Society for Curriculum Study, Inc., 425 West 123d Street, New York. (*Building America.*)

State Boards of Health. (Send for publication lists.)

United States Government, Superintendent of Documents, Washington, D. C. (*Health.*)

United States Public Health Service, Washington, D. C. (*Public Health Report.*)

University of Chicago Press, Chicago. (Pamphlet 22, *Fundamentals of Good Medical Care;* and Pamphlet 28, *Doctors, Dollars and Disease.*)

University of Iowa Publications, State University of Iowa, Iowa City.

Western Institute of Light and Vision, 3407 Lowry Road, Los Angeles.

HOW SCIENTIFIC ARE YOU?

A Guide to the Pupil's Thinking

For your convenience we offer an outline of what it means to be "scientific." We suggest that you read it carefully, discuss it in class, refer to it often (especially when giving reports and current events), and use it as a self-check in your attempt to develop scientific habits of mind.

A. Concerning things you hear or read. For each statement, do you —

1. Consider the authority?
   a. Source: Is it a book, magazine, newspaper, or hear-say? (Which do you think is most *likely* to be accurate? Why?)
   b. Author: Who? Position? (Form the habit of reading the title page.)
   c. Type of statement: Direct quotation or reporter's write-up? (A reporter writes about things as he understands them, and sometimes he is in error.)
   d. Date? (Remember, new facts are being discovered constantly, and theories are changing accordingly.)
2. Distinguish between fact, theory, and opinion?
   a. Data: How much given? Are experiments described? If so, was the type of experiment and number of cases adequate? Were experiments carefully done?
   b. Opinion: Of how many persons? Who were they?
3. Draw your conclusions carefully, keeping an open mind on those questions for which you have insufficient evidence?

B. Concerning everyday applications of science. Do you actually *use* your knowledge of science to help you to —

1. Increase your health, energy, and efficiency?
2. See more interest and meaning in everyday things?
3. Feel less afraid and superstitious, because you see everything as the effect of a definite cause?
4. Think and work scientifically? (See C, on page 556)

5. Find interest in scientific reading and hobbies?
6. Realize that you and the universe operate according to orderly laws to which you must adjust yourself? (To go contrary to these laws means to suffer the consequences.)

C. Concerning your methods of thinking and working. Do you —

1. Plan your work and life? (Have a goal, but make allowance for continual minor adjustments to changing circumstances.)
2. Think of the possible effects of your acts before deciding to do them? (Before trying an experiment, be sure it is wise. For example, don't put yourself on a "diet" until you know what you are doing.)
3. Try to find out why and how things happen as they do?
4. Observe things carefully and accurately before drawing a conclusion?
5. Try out your harmless theories by putting them into practice before being "cocksure"?
6. Listen open-mindedly to the opinions of others, then draw your conclusions as indicated under A of this outline?
7. Willingly change your opinion on the basis of new evidence?
8. Look for the whole truth, regardless of your personal prejudices?
9. Criticize your own work and that of others frankly but not boorishly? (Remember, scientific criticism is constructive whenever possible.)
10. Receive criticism graciously and objectively? (A truly scientific attitude makes it impossible to have your "feelings hurt.")

INSTRUCTIONS FOR HANDLING CHEMICALS[1]

1. Perform all experiments carefully and in such manner as to be least dangerous.
2. Follow directions carefully.
3. Use small quantities of materials, unless specifically directed to use larger amounts.
4. Perform only those experiments specifically designated and approved by the instructor.
5. In case of any accident, report to the instructor at once.
6. Protect your clothes. Wear a rubber apron.
7. Be sure all test tubes, beakers, and flasks are clean before you use them. Material left in containers from a previous experiment may cause an explosion.
8. In case of acid burn, wash the area immediately with plenty of water, then apply gauze saturated with sodium bicarbonate solution.
9. In case of alkali burn (sodium or potassium hydroxide), wash immediately with plenty of water, then apply gauze saturated with vinegar.
10. Never heat a stoppered container.
11. Never point the open end of a test tube toward your face or toward your neighbor while heating it.
12. Never bring gasoline, ether, carbon disulfide, alcohol, or other volatile or inflammable liquids near a flame.
13. Never add water to an acid (especially sulfuric acid), but cautiously add acid to the water.
14. Never taste or drink anything in the laboratory unless specifically directed to do so.
15. Never handle metallic sodium, potassium, red or white phosphorus. These should be used only in demonstrations by the teacher, if at all. (For exhibits of these elements, use their *salts*.)

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[1] From *Science Laboratory Regulations* of the Los Angeles City Board of Education. Reprinted by permission of Paul F. Devine, Supervisor of Science.

16. Never make explosive compounds or mixtures. Potassium chlorate must be used only in teacher demonstrations.
17. Never work in the laboratory unless an instructor is present.
18. Never pass your hand or arm over a lighted burner.
19. Never use concentrated strong acids unless directed to do so by the teacher. Strong acids are kept in storerooms inaccessible to students and given out only in the amounts required for experiments.
20. Never cut or use glass tubing until you have received proper instruction from the teacher.

Glossary

The explanations of items in this glossary are limited to the sense in which they are used in the text of this book.

abdomen (ăb-dō′mĕn): belly; the cavity containing the stomach, intestines, liver, pancreas, spleen, and certain other organs; located between the diaphragm and the pelvis

abdominal (ăb-dŏm′ĭ-năl): pertaining to the abdomen

abscess (ăb′sĕs): a localized collection of pus in the tissues of the body, usually characterized by pain, swelling, and redness

absorption (ăb-sôrp′shŭn): the process by which nourishing and other materials are taken up by the body through the lining of the digestive system into the blood stream

accelerator (ăk-sĕl′ĕr-ā′tĕr): a mechanism or drug that increases the speed of an organ

accommodation: the power of the eye to focus on near and far objects

acne (ăk′nē): an inflammatory disease of the oil glands of the skin, characterized by pimples

adenoids (ăd′ĕ-noids): an enlargement of the connective tissue at the upper part of the throat at the end of the nasal cavity

adolescent (ăd′ō lĕs′ĕnt): the process or period of growing from childhood to maturity

adrenalin (ăd-rĕn′ăl ĭn): the hormone from the adrenal glands; a stimulant and astringent

aerate (ā′ĕr-āt): to supply or charge with some type of gas or air

afferent: the nerve impulse which is transmitted *from* a sense organ *into* a nerve center

agglutinins (ă-gloo′tĭ-nĭns): substances formed in the blood in response to the irritation of certain disease germs. These substances clump the bacteria together so they may be destroyed more easily

air conditioning: the process of cleaning air and keeping it at the right temperature and proper moisture for comfort

alimentary (ăl-ĭ-men′tă-rĭ) **canal**: a specialized tube running through the body, and serving as a means of food (aliment) storage, digestion, absorption, and elimination

alkali (ăl′kă-lī): a substance such as bicarbonate of soda having basic properties and the ability to neutralize acids and form salts with them. The stronger alkalies are lyes

alkaline (ăl′kă-līn): A substance having the properties of an alkali

allergy (ă′lĕr-jĭ): abnormal sensitiveness of the body to certain substances such as serum, pollen, foods, hair, dust, etc.

alveolus (ăl-vē′ō-lŭs, pl. ăl-vē′ō-lī): microscopic air sac in the lungs

ameba (ă-mē′bă): a one-celled microscopic animal. Most convenient organism for study of simplest form of life. Consists of a mass of protoplasm and moves about in stagnant water

amino (ă-mē′nō) **acids**: the end products into which protein foods are separated during digestion. Twenty-two different types are essential for human health

amylase (ăm′ĭ-lās): digestive enzyme in pancreatic juice

anemia (ă-nē′mĭ-ă): deficiency of red corpuscles. When this condition exists, one is said to be anemic

anesthetic (ăn′ĕs-thĕt′ĭk): a drug that temporarily paralyzes nerve tips, so that pain is not felt. A **local anesthetic** affects a small area only; a **general anesthetic** affects the brain, rendering the patient unconscious

anterior: situated toward the front of the body; opposite to *posterior*

antibodies (ăn′tĭ-bŏd′ĭz): substances formed in the blood which destroy or help to destroy disease germs or counteract their poisons

antiseptic (ăn′tĭ-sĕp′tĭk): a substance destructive to disease germs; or one that prevents decay

antitoxin: a substance produced by animal bodies; it overcomes the harmful effects of the toxins of disease germs

aorta (ā-ôr′tă): the great artery which is the main trunk of the arterial system. It carries blood from the left ventricle of the heart to all parts of the body except the lungs

apoplexy (ăp′ō-plĕk-sĭ): a condition caused by the rupture of a blood vessel in the brain or spinal cord

appendage (ă-pĕn′dâj): something appended to the principal thing, *i.e.*, legs and arms are appendages of the body

appendix (ă-pĕn′dĭks): a wormlike organ, situated at the junction of the small and large intestine, on the right side of the abdomen. It has no known purpose

arteriole (är-tē′rĭ-ole): a very small artery

arteriosclerosis (är-tē′rĭ-ō-sklê-rō′sĭs): a hardening of the walls of the arteries

artery (är′tẽr-ĭ): a blood vessel that carries the blood away from the heart

aseptic (ȧ-sĕp′tĭk): free from disease germs

assimilation (ă-sĭm′ĭ-lā′shŭn): the changing of food into protoplasm

astringent (ăs-trĭn′jĕnt): a substance which constricts certain tissues. Often used to stop bleeding

atoms: the smallest particles of which all matter, living or nonliving, is made up

auditory: pertaining to the sense of hearing. The *auditory nerve* connects the ear with the brain

auricles (ô′rĭ-k'ls): the two upper chambers of the heart which receive blood from the veins. Also, the outer portions of the ears

autonomic (ô′tō-nŏm′ik): pertaining to the involuntary (sympathetic and parasympathetic) nervous system, which is nearly but not quite independent of the central nervous system

axon (ăk′sŏn): a long nerve fiber that carries messages from the cell body with which it is connected. Long branch of the neuron

bacillus (bȧ-sĭl′ŭs): a rod-shaped bacterium which may or may not cause disease

bacteria (băk-tēr′ĭ-ȧ): a microscopic form of plant life. Some of them are beneficial, others cause more or less serious diseases

basal metabolism: the very lowest amount of calories needed to keep the body alive, sustain its warmth, and maintain muscle tone, breathing, and heart action

Beriberi (bĕr′ĭ-bĕr′ĭ): a disease of the nervous system caused by the lack of vitamin B

biceps (bī′sĕps): the large muscle on the front of the upper arm

bicuspids (bī-kŭs′pĭds): teeth used for both cutting and grinding food. Third and fourth teeth from center front on each jaw

bile (bīl): A yellow or greenish juice secreted by the liver into the intestines and needed for digestion of fat

bile duct: the duct carrying bile from the liver and gall bladder to the duodenum

blackout: the elimination of all light sources for the purpose of protection from aerial bombings

bladder (urinary): a sac which serves as the receptacle of the urine

blood clot: a semisolid mass of blood cells held together by fibrin

blood count: a blood test to determine the number and proportions of white and red corpuscles

blood pressure: the pressure which the blood exerts in the blood vessels

bronchial (brŏn′kĭ-ăl) **tubes**: tiny tubes which branch off from the bronchi and carry air into the alveoli of the lungs

bulk: the undigestible parts of food like the cell walls of vegetables

bundle of His: a little strand of tissue between right and left halves of the heart, which passes the stimulus from the pace maker to the ventricles

caecum (sē′kŭm): the beginning portion of the large intestine

callous (kăl′ŭs): a thickening of cuticle that forms a protecting pad on the surface of the skin

Calorie (kăl′ō-rĭ): the unit by which heat is measured. A small calorie is the amount of heat required to raise 1 gram of water 1° C.; a large Calorie (used in measuring food values) is the amount of heat required to raise 1 kilogram of water 1° C.

capillary (kăp′ĭ-lâ-rĭ): minute blood vessels whose length is less than $\frac{1}{20}$ inch. They connect the smallest arteries with the smallest veins

carbohydrate (kär′bō-hī′drāt): a chemical substance composed of carbon, hydrogen, and oxygen. Examples are starch and sugar

carbon (kär′bŏn): an element found in lampblack, charcoal, diamonds, etc.; a component part of protoplasm

carbon dioxide (kär′bŏn dī-ŏk′sīd): a gas composed of two parts of oxygen and one part of carbon

cardiac (kär′dĭ-ăk): pertaining to the heart
carotene (căr′ô-tēn): a yellow plant pigment that is converted into vitamin A when administered to the body. The main sources of carotene are vegetables, especially carrots, and fruits
carrier: an apparently healthy person who carries disease germs in his body
cartilage (kär′tĭ-lĭj): a firm, tough, elastic tissue having something of the rigidity of bones, yet capable of bending under pressure
cell (sĕl): a microscopic, structural unit of all plant and animal life
cellulose (sĕl′û-lōs): an organic compound found in the cell walls of nearly all plant cells, but not commonly found in animal cells
cell wall: a thick bounding layer that covers most cells
central nervous system: composing the brain and spinal cord
cerebellum (sĕr′ê-bĕl′*ŭ*m): the midportion of the brain below and behind the cerebrum; concerned with movement
cerebrospinal (sĕr′ê-brô-spī′n*ă*l) **system:** the nervous system consisting of the brain and spinal cord
cerebrospinal fluid: corresponds to lymph; it is located between the dura mater and spinal cord
cerebrum (sĕr′ê-br*ŭ*m): the upper two hemispheres of the brain; the seat of intelligence and thought
chemical energy: energy stored in or released from a chemical compound, as gasoline, dynamite, or food
chlorophyll (klō′rô-fĭl): the green coloring matter of plants
choroid coat (kō′roid kōt): the black membrane between the retina and the sclerotic coat of the eye
chronic (krŏn′ĭk): lasting, as a lingering disease
chyme (kīm): semifluid condition of food after it has been digested by the stomach
cilia (sĭl′ĭ-ȧ): tiny, delicate hairs surmounting the mucous membranes of the nose and throat
ciliary muscle: helps to focus by changing shape of lens
circulation: the movement of blood in the veins and arteries throughout the body
circulatory (sûr′kû-l*ȧ*-tô-rĭ) **system**: an arrangement of tubes for transporting blood to every cell in the body
cirrhosis (sĭ-rō′sĭs): the scarring effect that results in injury to the liver
coagulation (kô-ăg′û-lā′sh*ŭ*n): the process of solidification of a liquid, as the clotting of blood
coccus (kŏk′*ŭ*s), pl. cocci (kŏk′sī): any round bacterium
cochlea (kŏk′lê-*ȧ*): the organ of hearing in the inner ear; so called from its resemblance to a snail shell
colitis (kô-lī′tĭs): an inflammation of the colon
colon ((kō′l*ŏ*n): the large intestine
combustion (k*ŏ*m-bŭs′ch*ŭ*n): a chemical change in which materials are destroyed to form other materials; the process of burning
communicable: capable of being transferred from one person to another; contagious
compound: a substance composed of two or more kinds of elements in chemical combination
concussion (k*ŏ*n-kŭsh′*ŭ*n): depressed organic function, especially of the brain, due to a shock, such as a severe blow
conditioned reflex: an acquired pathway in an animal's nervous system; an acquired behavior pattern that is so automatic it appears like a true reflex
congestion: an abnormal and excessive accumulation of blood in the vessels of an organ, causing disorder of its functions
conservation of matter and energy: the basic law of the whole universe: "Matter or energy cannot be created nor destroyed but only changed from one form to another"
constipation (kŏn-stĭ-pā′sh*ŭ*n): inactivity or obstruction of the colon, causing food residues to become packed and delaying elimination
constituent (c*ŏ*n-stĭt′û-*ĕ*nt): a part of something; for example, flour is a constituent of bread
constriction: act or state of being drawn together
contagious (c*ŏ*n-tā′j*ŭ*s): capable of being communicated from one person or animal to another by direct or indirect contact
convolutions (kŏn′vô-lū′sh*ŭ*ns): furrows or ridges on the outer surface of the brain
co-ordination: the working together in complete harmony and control, as in muscles
cornea (kôr′nê*ȧ*): the transparent part of the outer coat of the eyeball through which the light passes. It is composed of very tough connective tissue which serves as a protecting wall to the eye
corpuscles, red: flattened round disks

normally contain hemoglobin and serve to carry oxygen. **white:** round, colorless cells, some of which aid in fighting disease by destroying germs and other harmful substances

corrugated (kŏr′ōō-gāt-ĕd): having folds or wrinkles like a washboard

cortex (kôr′-tĕks): the outer layer of an organ, especially the brain

counteract: to act in opposition; neutralize

cranial nerves: twelve pairs of nerves coming directly from the brain

cranium (krā′nĭ-*ŭ*m): the bony receptacle for the brain

cretin (krē′tĭn): a child lacking intelligence because of insufficient thyroxin

crystalline substance: a substance which will dissolve in water

cuticle (kū′tĭ-k'l): an upper, hard portion of the protective covering of the body; composed of flat, hard cells

cytoplasm: that portion of the protoplasm of a cell which lies outside the nucleus

decomposition (dê-kŏm′pô-zĭsh′*ŭ*n): the separation of a substance into its original parts or elements by chemical action or by decay

deficiency disease: any disease caused by lack of a certain type of food

degenerate: to become less and less capable or useful

dehydrate (dē-hī′drāt): to deprive or free of water or the elements of water

delirium tremens (dê-lĭr′ĭ-*ŭ*m trē′mĕnz): violent mental disturbance caused by excessive and prolonged use of alcohol

deltoid (dĕl′toid): triangular muscle which covers the shoulder joint and serves to raise the arm sidewise

dentifrice (dĕn′tĭ-frĭs): a preparation for cleaning teeth

dentine (dĕn′tĭn): a hard substance which forms the major part of a tooth

depressant: anything which causes one to feel lower, duller, or discouraged; a drug which lowers the normal rate of activity of an organ, *e.g.*, causing the heart to beat more slowly

dermis (dûr′mĭs): all the skin underneath the mother-cell layer of the skin, *i.e.*, under the epidermis

diabetes (dī′*ȧ*-bē′tēz): a disease in which the sugar of the body is not completely burned, owing to unsufficient function of the pancreas

diaphragm (dī′*ȧ*-frăm): a muscle sheath between the abdominal and chest cavities

diastole (dī-ăs′tô-lē): the relaxation period of the heart; the period when the heart expands

diffuse (dĭ-fūz′): to pour or spread out in all directions

digestion (dī-jĕs′ch*ŭ*n): a process of converting food into a form that can be used to build tissue and furnish energy

dilate (dĭ-lāt′): to expand, open up, spread apart; the opposite of contract

diphtheria (dĭf-thē′rĭ-*ȧ*): an infectious disease characterized by fever, sore throat, and a membrane on the throat

disinfectant (dĭs′ĭn-fĕk′t*ă*nt): an agent which destroys germs

dorsal (dôr′s*ă*l): situated near or on the back of an animal

duodenum (dū′ô-dē′n*ŭ*m): the first 10 inches of the small intestine

duct: a canal or tube for carrying fluids in the body

ductless (endocrine) gland: any gland secreting a hormone directly into the blood

dura mater (dū′r*ȧ* mā′tẽr): the fibrous, dense outer covering of the brain

efferent: the nerve impulse which is transmitted *from* a nerve center *to* a muscle or gland

elasticity (e′lăs-tĭs′ĭ-tĭ): the property of a tissue to recover its former position or shape after being bent or deformed

element: a substance that cannot be decomposed into simpler substances by any known chemical means

endocrine (ĕn′dô-krĭn): pertaining to the ductless glands, or glands of internal secretion

endolymph (ĕn′dô-lĭmf): the fluid that is contained within the membranous labyrinth of the inner ear

end plate: sensory or muscle end organ of a neuron

end product: the conclusion in the digestion of a food; the final product

energy: the capacity to do work

environment: the surroundings of any living thing

enzyme (ĕn′zīm): an organic compound which hastens a chemical change without being used up itself

epidemic (ĕp′ĭ-dĕm′ĭk): a disease or condition which affects a large number of people at once

epidermis (ĕp′ĭ-dûr′mĭs): the protective covering of the body, including the mother skin cells and all the skin cells outside them

epiglottis (ĕp′ĭ-glŏt′ĭs): the flap of tissue that covers the top of the windpipe during swallowing

epithelium (ĕp′ĭ-thē′lĭ-ŭm): tissue covering a free surface or lining a cavity of the body

ergosterol (ẽr-gŏs′tẽr-ōl): an oily substance found in the blood and in living cells, which is activated into vitamin D by ultraviolet light

esophagus (ē-sŏf′ȧ-gŭs): the tube which connects the pharynx with the stomach

Eustachian (ū-stā′kĭ-ăn) **tube:** the tube connecting the middle ear with the throat

evaporation: the process of converting a liquid or solid into a gas or vapor

excretion (ĕks-krē′shŭn): the production and elimination of body wastes

excretory (ĕks′krē-tō-rĭ) **system:** the organs which eliminate (remove) wastes from the body

expire: to breath out, to emit from the lungs, to throw out from the mouth or nostrils in the process of respiration

Fahrenheit (fär′ĕn-hīt) **scale:** a thermometric scale whose boiling point of water is 212° above zero

feces (fē′sēz): the discharge from the intestines or bowels

femur (fē′mŭr): the long bone in the leg which extends from the hip to the knee; the thigh bone

fermentation (fŭr-mĕn-tā′shŭn): chemical changes brought about by yeast plants; the wastes are alcohol and carbon dioxide

fever (fē′vẽr): a condition characterized by increased body temperature, pulse and respiratory rates, and a disturbance of bodily functions

fibrin (fī′brĭn): a white, tough, stringy, elastic, fibrous substance, formed especially in the coagulation of blood

fibrinogen (fī-brĭn′ō-jĕn): a protein found in the blood, lymph, etc., and yielding fibrin in the coagulation of blood

fibrous (fī′brŭs): containing, consisting of, or resembling fibers

filterable (fĭl′tẽr-ȧ-b'l): capable of passing through a standard filter such as the porcelain filter

fissures: cracks such as those which separate the lobes of the brain

fistula (fĭs′tû-lȧ): a narrow passage or duct formed by disease or injury, as one leading from an abscess to a free surface, or one forming an abnormal means of communication with some normal cavity

flexor (flĕk′sŏr): a muscle which serves to flex (bend) a part of the body

focal infection (fō′kăl ĭn-fĕk′shŭn): a condition whereby some part of the body becomes diseased as the result of its invasion by disease organisms or toxins, the source of which is elsewhere in the body, for example, the tonsils or teeth

follicle (fŏl′ĭ-k'l): a fold in the skin containing a hair's shaft or root

food: any substance that can be oxidized within a living cell or used in building new protoplasm

function (fŭnk′shŭn): use or work of any living thing or part thereof

fundus (fŭn′dŭs): the base of an organ, or the part opposite to or remote from an aperture; the part of the stomach where food settles

gall bladder: the sac in which bile is stored; it is attached to the liver

ganglion (găng′glĭ-ŏn): a group or mass of nerve cell bodies

gangrene (găng′grēn): the dying of tissue due to interference with local nutrition

gastric glands: the tiny glands contained in the lining of the stomach which secrete juice to digest proteins

gastric juice: the digestive juice of the stomach which acts on protein foods

general sensations: every sense other than the five special senses, as hunger, thirst, cold, hot, etc.

germ (jûrm): a microorganism capable of producing disease provided conditions are favorable for its growth

germicidal: able to kill germs

germicide (jûr′mĭ-sīd): an agent which kills germs, as tincture of iodine

gland: an organ that separates certain substances from the blood for use in the body, or for elimination

glomerulus (glō-mĕr′-o͝o-lŭs): one of millions of tiny clusters of blood vessels in the kidneys, through which wastes are removed from the blood

glucose (gl͞oo′kōs): a simple sugar sometimes called "grape sugar," occurring in nature as dextrose

glycerine (glĭs′ẽr-ĭn): a sweet, colorless, sirupy liquid; one of the end products of fat digestion, the others being fatty acids

glycogen (glī′kō-jĕn): a complex compound of sugar, formed from carbohydrates by the liver which stores it until needed by the muscles

goiter (goi′tẽr): a disease involving an

enlargement of the thyroid gland; it is sometimes accompanied by prominence of the eyeballs
gonads (gŏn′ăds): the sex glands
gray matter: nerve tissue composed mostly of nerve cells and some fibers without any sheath
groin: the junction of the lower part of the abdomen and the thigh, or the region about it
gustatory (gŭs′t*ȧ*-tô-rĭ): pertaining to the sense of taste

hemoglobin (hē′mô-glō′bĭn): the iron-containing substance in the red corpuscles, chiefly noted for its ability to carry oxygen in chemical combination
hemophilia (hē′mô-phĭl′ĭ*ȧ*): a hereditary disease in which the blood does not clot; its victims are called "bleeders"
hemorrhage (hĕm′*ŏ*-râj): the escape of blood from injured blood vessels
hepatic (hê-păt′ĭc): relating to the liver
heredity (hê-rĕd′ĭ-tĭ): the transmission of qualities or characteristics from parents or ancestors to their children
hives (hīvz): an eruptive disease of the skin, believed to be caused by an allergic or hypersensitive condition of the body
hookworm: a small many-celled, round worm which causes hookworm disease
hormone (hôr′mōn): a secretion from glands in which the product of the gland is not passed out through a duct, but passes directly into the blood
host (hōst): an organism upon which another lives as a parasite
humidity (hû-mĭd′*ĭ*-tĭ): moisture in the atmosphere

ileocecal (ĭl′ê-ô-sē′k*ă*l) **valve:** a valve which separates the small intestine from the large
ileum (ĭl′ê-*ŭ*m): the third and lowest division of the small intestine
immune (ĭ-mūn′): able to resist a certain disease
immunity (ĭ-mū′nĭ-tĭ): ability to resist a disease
impulse (ĭm′pŭls): the change in the setup of nerve fibers by means of stimuli coming either from the endings of the nerve in the cells of the body or from the brain or spinal cord. The impulse is a force that travels along a nerve
incisors (ĭn-sī′zẽrz): the teeth for cutting; one of the cutting teeth in front of the canines in either jaw
incubation period: the time of development of an infectious disease from exposure to it until the symptoms appear
incus (ĭn′k*ŭ*s): anvil, a bone in the middle ear
indigestion (ĭn-dĭ-jĕs′ch*ŭ*n): lack of normal digestion
infantile paralysis or **poliomyelitis** (pŏl′ĭ-ô-mī′ê-lī′tĭs): paralysis due to inflammation and atrophy (waste or withering) of the gray matter of the spinal cord
infection (ĭn-fĕk′sh*ŭ*n): the state produced by the entrance into, and multiplication within, the body, of disease-producing organisms. **acute i.**, one which begins suddenly and reaches a crisis rapidly (such as pneumonia). **chronic i.**, one which continues over a period of months or years (such as tuberculosis). **focal i.**, one which acts as a *focus*, or center, from which germs spread to set up infections in other parts of the body (abscessed tonsils or teeth may sometimes be of this type). **generalized i.**, one which involves the whole body because the blood contains active bacteria or toxins (such as influenza). **latent i.**, one which is inactive though germs are present (such as tuberculosis if in an inactive state). **local i.**, one that is confined to one spot or area (such as a boil)
infectious (ĭn-fĕk′sh*ŭ*s): that which may be communicable or caused by infection
inflammation (ĭn-fl*ă*-mā′sh*ŭ*n): a succession of changes in living tissue, due to injury, usually indicated by the suffix "itis" as in bronchitis; a congestion manifested by redness, swelling, heat, and pain
inhibit (ĭn-hĭb′ĭt): to hold back or in
inhibition (ĭn-hĭ-bĭsh′*ŭ*n): the delay or complete suppression of a response to a stimulus
inoculate (ĭn-ŏk′û-lāt): to communicate a disease by injecting its germs
inoculation (ĭn-ŏk′û-lā′sh*ŭ*n): an injection of serum or vaccine into the body
inorganic (ĭn-ŏr-găn′ĭk): anything that is not alive and not produced by living things
inspiration (of air) (ĭn′spĭ-rā′sh*ŭ*n): the act of breathing in
instinct: an inborn tendency to perform a certain action under a certain condition
insulin (ĭn′sû-lĭn): a hormone made by the pancreas and delivered directly into the blood stream. This hormone is necessary in the oxidation of sugar;

when not produced by the pancreas, diabetes results

intercostal (ĭn′tẽr-kŏs′tăl): between the ribs

intermediary products: a step during the digestive process, between the food and its end product

intestinal glands: tiny glands in the walls of the small intestines which secrete intestinal juice

intravenous (ĭn′trȧ-vē′nŭs): within a vein

iodine (ī′ō-dĭn): an element necessary for balanced nutrition. Necessary for prevention and cure of goiter; its tincture kills germs

iris: a circular muscle of the eye which controls the size of the pupil; the colored part of the eye surrounding the pupil

irritability: the responsiveness of living matter to more or less rapid changes in external conditions, manifested by motion, change of form, and in other ways

jaundice (jän′dĭs): yellowness of the skin and conjuctiva due to the presence of bile pigment in the blood

joint: connection between bones

kidneys: two bean-shaped organs which assist in removing waste from the blood stream

kinetic (kĭ-nĕt′ĭk): due to motion. **k. energy,** energy that is doing work; as energy of the wind, river, or waterfall

lachrymal (lăk′rĭ-măl): pertaining to tears; the gland that secretes tears; the duct which carries them over the eyeball; and the secretion itself

lacteals (lăk′tē-alz): the lymphatic vessels of the small intestine

larynx (lăr′ĭnks): the upper part of the air tube, containing the vocal cords

laxative (lăk′sȧ-tĭv): a substance which stimulates the peristaltic action of the intestines

lens: the focusing portion of the eye

lesion (lē′zhŭn): any unhealthy change in the structure of a part of the body

lethal: deadly; causing death in a given or prescribed time

leukocyte (lū′kō-sīt): a white corpuscle capable of movement which has a three-lobed nucleus; ingests bacteria

ligaments (lĭg′ȧ-mĕnts): bands of fibrous tissue serving to connect bones and give strength to joints, as well as to hold certain organs in place

liver (lĭv′ẽr): the largest gland in the body; situated in the upper part of the abdomen; secretes bile; stores sugar in form of glycogen; removes certain wastes from the blood

lobules (lŏb′ūlz): small lobes or subdivisions of lobes

lumbar: pertaining to the region near the loins; the "small of the back"

lymph (lĭmf): the fluid that bathes the cells and lies in the spaces between them. It is derived from the plasma in the blood and is returned to the blood stream by the lymphatics

lymphatics (lĭm-făt′ĭks): tubes composed of thin cells which carry lymph from the cells and tissue spaces back to the blood stream

lymph nodes: small glandular structures situated along the course of the lymphatics and especially numerous at the joints. They serve to take poisons out of the lymph

lymphocytes (lĭm′fō-sītes): type of white corpuscle having a simple large round nucleus surrounded by a rim of clear protoplasm

lysins (lī′sĭnz): substances in the blood which dissolve bacteria and other foreign cells; also called bacteriolysins

malaria (mȧ-lā′rĭ-ȧ): "bad air," a febrile disease associated with the presence in the blood of a protozoan parasite

mammals (măm′ălz): animals, usually four-footed, that produce milk for their young

massage (mȧ-säzh′): a "rubdown," treating the body by rubbing, kneading, or tapping

mastoid (măs′toid): bone behind the ear

matter: anything that is made up of molecules or atoms; anything that has weight and occupies space. Its three forms are gas, liquid, and solid

mechanism (mĕk′ȧ-nĭz′m): any machine-like action

medulla oblongata (mē-dŭl′ȧ ŏb′lŏng-gā′tȧ): the lowest part of the brain, communicating with the spinal cord

medullated (mĕd′ŭ-lāt′ĕd): covered with a soft fatty substance, that is, with a medulla

membrane (mĕm′brān): a very thin, soft layer of tissue

meninges (mē-nĭn′jēz): three membranes enveloping the brain and spinal cord

mental hygiene: the study of keeping mentally healthy, *i.e.*, of forming and preserving good mental habits

mesentery (mĕs′ĕn-tĕr-ĭ): in vertebrates, the membranes which envelop the intestines and attach them to the body wall

metabolic (mĕt′*ȧ*-bŏl′ĭk) **rate:** the speed at which metabolism takes place

metabolism (mê-tăb′ô-lĭz′m): the energy-producing chemical changes in the body of any living organism

metatarsal (mĕt′*ȧ*-tär′s*ă*l): pertaining to the arch across the ball of the foot

microbe, microorganism (mī′krô-ôr′g*ă*n-ĭz′m): an organism of the animal or vegetable kingdom so small that it can be seen only through the microscope

mineral salts: salts derived from inorganic acids or substances found in earth having definite chemical composition

mixture: the result of the mixing of elements where in each case the atoms of either substance do not chemically unite with one another

molecule (mŏl′ê-kūl): the result of the chemical joining of two or more atoms; the smallest part of a compound

morphine (môr′fēn): a crystalline narcotic derived from opium

mortality (môr-tăl′ĭ-tĭ): the death rate among a given number of individuals (usually expressed in per cent)

motor (mō′tẽr): that which causes motion

motor nerves: efferent; nerves carrying impulses from the brain or spinal cord to the muscles

mucous (mū′k*ŭ*s): relating to mucus. **m. membrane,** the membrane lining those cavities of the body, as the mouth, which communicate with the exterior

mucus (mū′k*ŭ*s): a slimy, slippery secretion produced by the mucous membranes, which it moistens and protects

multicellular (mŭl′tĭ-sĕl′û-lẽr): consisting of, characterized by, or pertaining to many cells

myopia (mī-ō′pĭ-*ȧ*): see **nearsightedness**

myxedema (mĭk′sê-dē′m*ȧ*): a disease due to the lack of thyroid secretion; it is accompanied by a pouchy appearance of the skin and dull intellect

narcotic (när-kŏt′ĭk): any substance that relieves pain, blunts the senses, or induces sleep; when used intelligently, narcotics have been a blessing to man, but when used otherwise, they constitute a grave danger

nausea (nô′shê-*ȧ*): a sensation tending to cause vomiting

nearsightedness: seeing distinctly at short distances only; myopia

nerve: a cordlike cable of nerve fibers (neurons) that connect parts of the nervous system and conduct impulses either to or away from these parts

nerve center: a group of nerve cells meshed together by synapses

nerve fiber: a protoplasmic extension from a nerve cell body

nerve impulse: see **impulse**

nerve tissue: a group of cells called neurons, which carry and send impulses from one part of the body to the other

neuron (nū′rŏn): a single nerve cell

neutralize (nū′tr*ă*l-īz): counteract, destroy certain characteristics

nucleus (nū′klê-*ŭ*s): a tiny life center within the protoplasm which controls the functions of a cell

oculist (ŏk′û-lĭst): a medical doctor who is skilled in the examination and treatment of eye conditions

olfactory (ŏl-făk′tô-rĭ): pertaining to the sense of smell

opaque (ô-pāk′): not allowing light to go through; not transparent

opium (ō′pĭ-*ŭ*m): a narcotic derived from poppy

opsonin (ŏp′sô-nĭn): a type of antibody formed in the blood when bacteria invade the body, for the purpose of helping the white corpuscles digest and destroy the bacteria

optic (ŏp′tĭk): of or pertaining to the eyes or sight

optician (ŏp-tĭsh′*ă*n): one who makes or sells optical glasses and instruments

optometrist (ŏp-tŏm′ê-trĭst): one skilled in testing the eyes and fitting them with glasses, and legally authorized to do so, but not an oculist or a physician

organic (ôr-găn′ĭc): pertaining to an organ or organs; arising from an organism; in chemistry, a compound containing carbon; belonging to, or derived from, living animals or plants

organism (ôr′g*ă*n-ĭz′m): an individual constituted to carry on the activities of life by means of parts or organs which are separate and yet depend upon each other

osmosis (ŏs-mō′sĭs): the ability of two fluids separated by a porous membrane or tissue to pass through it until they are well mixed

oxidation (ŏk′sĭ-dā′sh*ŭ*n): the uniting of a substance with oxygen whether it be rapid (producing a flame) or slow, as in forming rust

oxygen (ŏk′sĭ-jĕn): a tasteless, colorless,

odorless gas found in air and very necessary for life and for burning
oxygenated blood: blood that has taken on a fresh supply of oxygen

palate (păl′ât): the roof of the mouth formed by two bones
pancreas (păn′krê-*ă*s): a tonguelike organ lying below the stomach, which secretes enzymes for digestion; it also secretes insulin
papilla (pă-pĭl′*ȧ*): a ridge containing highly specialized nerve endings
parasite (păr′*ȧ*-sīt): an organism that lives on or in another, called its host, from which the parasite derives its nourishments
parathyroids (păr′*ȧ*-thī′roidz): glands located near the thyroid. They secrete a hormone which regulates the body's assimilation of calcium
pasteurization: the process of treating milk by heating it to 140° F. for a few minutes, and then cooling it rapidly to kill most of the organisms in it
patent medicine: a medicine whose manufacture and sale are restricted legally as by patent, or registry of name as a trademark. Its value may be considerable, or little. The latter predominates
pathology (p*ȧ*-thŏl′ô-jĭ): a science which treats of diseases, their nature, causes, progress, and symptoms
pellagra (pĕ-lā′gr*ȧ*): a skin disease caused by lack of vitamin G
pelvic (pĕl′vĭk): relating to the pelvis, the basin of the abdomen
pepsin (pĕp′sĭn): an enzyme of the stomach
peptone (pĕp′tōn): partly digested protein; intermediary product of protein digestion
peristalsis (pĕr′ĭ-stăl′sĭs): the wavelike contraction that passes along tubes, such as the intestines and blood vessels; it is due to contraction of the circular and longitudinal muscle fibers; the action by which food is moved forward
peritoneum (pĕr′ĭ-tô-ne′*ŭ*m): the delicate membrane lining the abdominal cavity; it covers the surfaces of the various organs in that region
peritonitis (pĕr′ĭ-tô-nī′tĭs): an inflammation of the peritoneum
perspiration (pûr′spĭ-rā′sh*ŭ*n): the salty fluid secreted by the sweat glands; sweat
phagocyte (făg′ô-sīt): a white blood corpuscle that absorbs or destroys waste and harmful material or bacteria in the blood or tissues of the body
pharynx (făr′ĭnks): the cavity between the mouth and the esophagus
phosphorus (fŏs′fŏr-*ŭ*s): an element necessary for proper nutrition
physiology (fĭz′ĭ-ŏl′ô-jĭ): the science of the work and functions of the parts of the body
pigment (pĭg′m*ĕ*nt): any substance that gives color to animal or vegetable tissues as exhibited in the skin, hair, and the flowers of plants
pineal (pĭn′ē-*ă*l): a ductless gland located at the base of the skull cavity
pituitary (pĭ-tū′ĭ-tĕr′ĭ) **body:** a ductless gland situated at the base of the brain
plasma (plăz′m*ȧ*): the liquid part of the blood, a colorless fluid in which all of the corpuscles, food waste products, and gases float
platelets: irregularly shaped cells much smaller than red or white corpuscles. They play an important part in blood clotting
poliomyelitis: see **infantile paralysis**
polluted: contaminated or mixed with impurities
posterior (pŏs-tēr′ĭ-ēr): located behind or toward the hind end; opposite of *anterior*
potential energy: stored energy, as that in food or an electric battery
processes: irregular projections from a central body
protein (prō′tê-ĭn): a class of foods, such as lean meat and egg white, composed of carbon, hydrogen, oxygen, nitrogen, and sometimes other elements
proteoses (prō′tê-ōs′ēz): partly digested proteins; intermediary products of protein digestion
protoplasm (prō′tô-plăz'm): a colorless, complex, semifluid substance contained within the cell; the basic substance of all living cells
protozoa (prō′tô-zō′*ȧ*): simple, one-celled animals
ptyalin (tī′*ȧ*-lĭn): a digestive enzyme in saliva which aids in changing starch to glucose
pulmonary (pŭl′mô-nâ-rĭ): pertaining to the lungs
pulse: the rhythmical beat or throbbing in the arteries due to the contraction of the heart
pupil: small opening in the center of the iris which appears like a black spot in the middle of the eye
pus: a sticky substance found in boils, infected wounds, etc., and consisting

of plasma, white corpuscles, bacteria, etc.; usually yellowish white, or greenish
pylorus (pĭ-lō′rŭs): the valve between the stomach and the duodenum
pyorrhea (pī′ŏ-rē′ȧ): a diseased condition of the mouth, characterized by formation of pus pockets around the teeth with shrinking of the gums and loosening of the teeth

quack: an ignorant or fraudulent pretender to medical skill, knowledge, and qualifications which he does not possess
quarantine (kwŏr′ăn-tēn): detention or isolation imposed upon ships, persons, etc., when suspected of carrying contagious disease organisms; the period of time depends upon the disease

reflex (rē′flĕks): an act not under control of the brain
reflex arc: a pathway through an animal's nervous system involving two or more neurons along which an impulse travels from the point of stimulus to the organs that make the response
renal (rē′năl): referring to the kidneys
rennin (rĕn′ĭn): an enzyme in gastric juice that curdles milk
residue: that which remains after a part is removed
respiration (rĕs′pĭ-rā′shŭn): the act of taking in and breathing out air
respiratory (rē-spīr′ȧ-tô′rĭ): pertaining to breathing
retina (rĕt′ĭ-nȧ): the inner coat of the eye containing nerve endings which receive an image
rickets (rĭk′ĕts): a disease of the bones caused by improper nutrition
ringworm: a parasitic disease of the skin, characterized by the formation of ring-shaped eruptions; athlete's foot is a type of ringworm
roughage: nondigestible material in food
rouleau (rōō′lō′): a small roll of coins or something similar, such as a small role of corpuscles

saliva (sȧ-lī′vȧ): a digestive juice secreted by glands near the mouth; it aids in digestion of starches
saprophyte (săp′rō-fīt): an organism which lives on dead organic matter; bacteria which cause decay of dead plant and animal matter are saprophytes
Schick (shĭk) **test:** a skin test used to determine immunity from or susceptibility to diphtheria
sclerotic coat (sklē-rŏt′ĭk kōt): tough white outer coat of eye
scurvy (skûr′vĭ): a deficiency disease caused by the lack of vitamin C
secrete (sē-krēt′): to produce and give off as a secretion
semicircular canals: the portion of the inner ear in which the sense of balance is located
sense: a power to perceive physical objects or conditions by means of certain organs such as the eye, ear, and nose
sense organ: a collection of nerve cells which receive impressions from without, such as an eye or taste bud
sensitivity: the capacity of protoplasm to feel or to be irritated by stimuli
sensory: pertaining to the senses; the **s. nerves** convey impulses from the sense organs to the brain or spinal cord
septic (sĕp′tĭk): containing decay-producing bacteria; showing signs of decay
serous (sē′rŭs) **membrane:** a membrane bathed constantly in a clear, slightly sticky liquid, like the blood serum
serum (sē′rŭm): the plasma or liquid part of the blood; such a fluid obtained as an antitoxin from the blood of animals and used to prevent or cure disease
sex-linked character: character that appears more often in one sex than in the other
sinus (sī′nŭs): a cavity in the skull bone which opens into the nose and contains air
skeleton: the bony supporting structure of an animal's body
soft palate: the back part of the roof of the mouth
solar plexus (sō′lȧr plĕk′sŭs): a large ganglion belonging to the autonomic system which co-ordinates peristaltic movement
spinal cord: the part of the nervous system within the vertebrae
spinal nerves: thirty-one pairs of nerves which carry impulses between the spinal cord and the body
spirillum (spī-rĭl′ŭm) pl. **spirilla:** a spiral-shaped bacterium
Spirochaeta (spī′rō-kē′tȧ) or **spirochete:** A group of spiral-shaped protozoa, having more spirals than the spiral bacteria. Syphilis is caused by a spirochete
spleen (splēn): a glandlike organ belong-

ing to the blood system and located to the left and back of the stomach

spore: a single cell produced by algae, fungi, mosses, ferns, and protozoa; it is capable of reproducing the organism

sprain (sprān): an injury from excessive stretching of a muscle, joint, etc.

sputum (spū′t*ŭ*m): mucus accumulating in or ejected from the mouth or throat

steapsin (stē̂-ăp′sĭn): a ferment present in the blood, pancreatic juice, etc. It breaks fat down into fatty acids and glycerine

sterile (stĕr′ĭl): free from microorganisms

sterilization (stĕr′ĭ-lĭ-zā′sh*ŭ*n): the process of making anything free from germs, as the sterilization of surgical instruments

stethoscope (stĕth′ō̂-skōp): an instrument for confining and amplifying sound

stimulant (stĭm′ū̂-l*ă*nt): a substance that quickens some bodily activity, as the effect of spirits of ammonia upon the pulse

stimulus (stĭm′ū̂-l*ŭ*s): anything which induces a response in a plant or animal

streptococcus (strĕp′tō̂-kŏk′*ŭ*s): a type of disease-producing coccus

striated (strī-āt′ĕd): cross-striped tissue found in voluntary muscles

subcutaneous (sŭb′kū̂-tā′nē̂-ŭs): under the skin

sucrose (sū′krōs): common sugar

susceptibility (s*ŭ*-sĕp′tĭ-bĭl′ĭ-tĭ): the capability of being infected by disease organisms; the degree of susceptibility varies from time to time

suture (sū′tû̮r): a type of joint found in the skull

synapse (sĭ-năps′): the point at which a nervous impulse passes from one neuron to another

synovial (sĭ-nō′vĭ-*ă*l) **fluid:** a secretion which lubricates the joints

systemic (sĭs-tĕm′ĭk): pertaining to the body as a whole; systemic circulation is the general system, or the circulation to the cells

system of organs: a group of organs that co-operate in a particular line of work, as the digestive system

systole (sĭs′tō̂-lē): the contraction of the heart and arteries

tactual (tăk′tû̮-*ă*l): of or pertaining to the sense, or the organs, of touch; derived from touch

tarsal (tär′s*ă*l): relating to the seven bones of the foot which form the instep

tartar (tär′t*ȧ*r): a mineral deposit on the teeth

taste bud: nerve ending of the sense of taste

temperature (tĕm′pẽr-*ȧ*-tû̮r): the degree of heat or cold

tendon: connective tissue which attaches muscles to bones or to other muscles

tetanus (tĕt′*ȧ*-nŭs): the name of a bacterial disease that causes contraction of the muscles; lockjaw; also, state of a muscle when undergoing contraction

tetany (tĕt′*ȧ*-nĭ): a disease caused by lack of the parathyroid hormone or by calcium deficiency

thoracic (thō̂-răs′ĭk): pertaining to the chest. **t. duct,** opening through which lymph enters the blood stream

thorax (thō′răks): the middle division of the body between the neck and the abdomen

thymus (thī′m*ŭ*s): a ductless gland whose hormone is believed to bear some relation to growth

thyroid (thī′roid): a ductless gland in the neck

thyroxin (thī-rŏks′ĭn): the hormone secreted by the thyroid gland

tissue (tĭsh′ū̂): a group of similar cells specialized in a certain line of work

tonic (tŏn′ĭk): something that stimulates certain body activities

tonsil (tŏn′sĭl): either of two oval masses or lymphoid tissue situated one on each side of the throat

tourniquet (tōōr′nĭ-kĕt): a bandage or other device which, when properly placed and twisted tight, stops bleeding

toxic (tŏx′sĭk): having a poisonous effect

toxin (tŏk′sĭn): an organic poison produced in living or dead organisms or generated by microorganisms; it is the causative agent of diseases, such as tetanus and diphtheria

trachea (trā′kē̂-*ȧ*): the windpipe; it connects the lungs with mouth and nose

tsetse (tsĕt′sē̂) **fly:** blood-sucking insect which transmits `the parasite that causes sleeping sickness

typhoid (tī′foid) **fever:** a disease spread by contaminated liquid or food containing the typhoid bacillus

ulcer (ŭl′sẽr): a sore on the surface of an organ

ultraviolet (ûl′tr*ȧ*-vī′ō̂-lĕt): invisible rays of the sun, lying outside the violet end of the visible spectrum

urea (ū′rē̂-*ȧ*): a soluble, colorless, crystalline substance formed in the oxidation

of proteins in the body, and excreted by the kidneys
ureter (ū-rē′tẽr): the tube leading from the kidneys to the bladder
urethra (ū-rē′thr*ȧ*): the tube which carries off the urine from the bladder
uric (ū′rĭk) **acid:** a white, odorless, nearly insoluble acid, resulting from incomplete combustion in the body

vaccination (văk′sĭ-nā′sh*ŭ*n): inoculation with vaccine, the purpose of which is to create immunity
vaccine (văk′sēn): a preparation of dead or weakened baccilli used for developing immunity to a certain disease
vacuole (văk′ū-ōl): a cavity within the protoplasm of a cell, containing a watery secretion or a gas
valve (vălv): an instrument which opens and closes, permitting the flow of gas or liquid in only one direction
varicose (văr′ĭ-kōs) **veins:** abnormally dilated veins, found especially in the legs; caused by overexercise and overburdening of the legs
vasoconstrictor (văs′ō-kŏn-strĭk′tẽr): a nerve which causes constriction or contraction of the blood vessels
vasodilator (văs′ō-dī-lā′tẽr): a nerve which causes dilation or expansion of blood vessels
vasomotor (văs′ō-mō′tẽr): relating to the nerves which control the size of the blood vessels; see **vasoconstrictor** and **vasodilator**
veins (vāns): the vessels that carry blood toward the heart
vena cava (vē′n*ȧ* kā′v*ȧ*): each of a pair of main trunk veins of the body
ventilation (vĕn′tĭ-lā′sh*ŭ*n): the process of removing impure air from buildings, mines, and other confined spaces and supplying fresh air so as to maintain the atmosphere in a constant state of purity
ventral: situated on or toward the front surface of the human body; opposite to *dorsal*
ventricle (vĕn′trĭ-k'l): one of the two lower chambers of the heart which pump blood out of the heart; also, hollow cavities, as in the center of the brain
venule (ven′ūl): a tiny vein
vertebra (vûr′tē-br*ȧ*): one of the irregular-shaped bones which form the backbone
villus (vĭl′ŭs): one of the thousands of fingerlike projections on the lining of the small intestine where digested food is absorbed
virulent (vĭr′o͝o-l*ĕ*nt): extremely poisonous or extremely powerful in causing disease
vital (vī′tăl) **resistance:** an individual's resistance against fatigue or disease
vitamin (vī′t*ȧ*-mĭn): an organic compound necessary in the blood to maintain a healthy organism; essential in the prevention of particular diseases
vitreous humor (vĭt′rē-*ŭ*s hū′mẽr): a jellylike substance back of the lens in the eyeball
vocal (vō′k*ă*l) **cords:** the membranes stretched across the top of the larynx which vibrate to produce sound

white matter: nerve tissue composed mostly of just axons with covering sheaths which give it a smooth, white appearance

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